(NASA-CR-151153) STS PAYLOADS MISSION CONTROL STUDY (CONTINUATION PHASE) Executive Summary Review (TRW Defense and Space Systems Group) 93 p HC A05/MF A01 CSCL 22B G3/16

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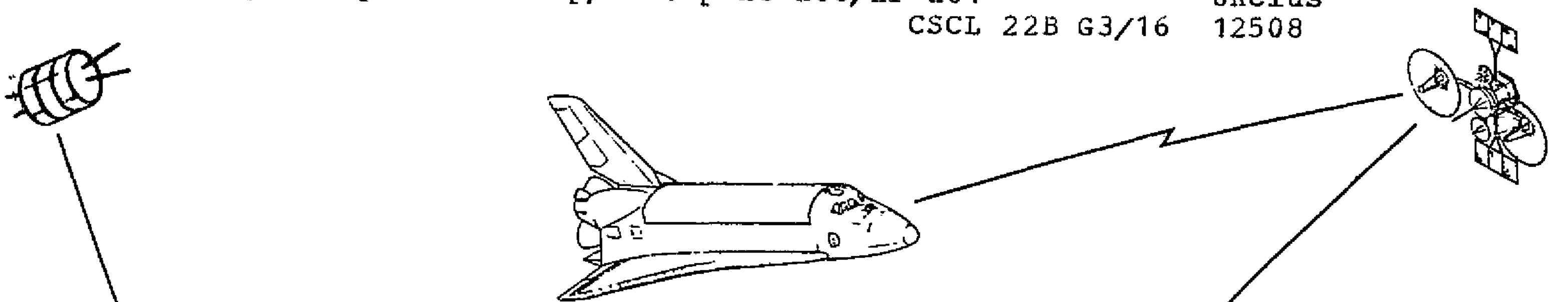

STS PAYLOADS MISSION CONTROL STUDY
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EXECUTIVE SUMMARY REVIEW

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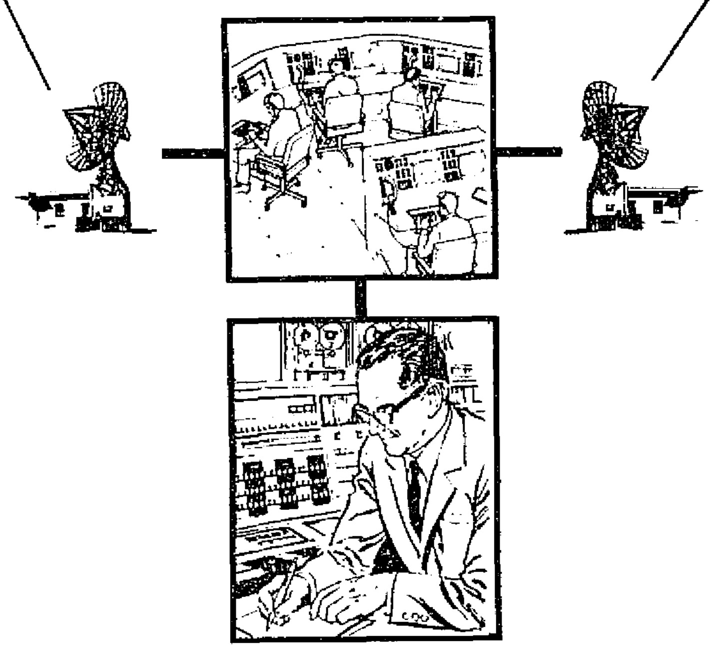

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DECEMBER 1976

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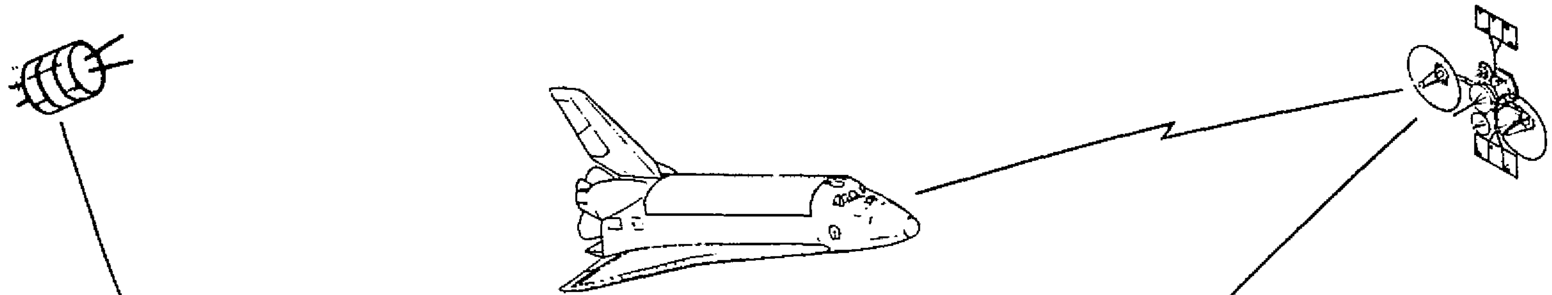

STS PAYLOADS MISSION CONTROL STUDY

CONTINUATION PHASE

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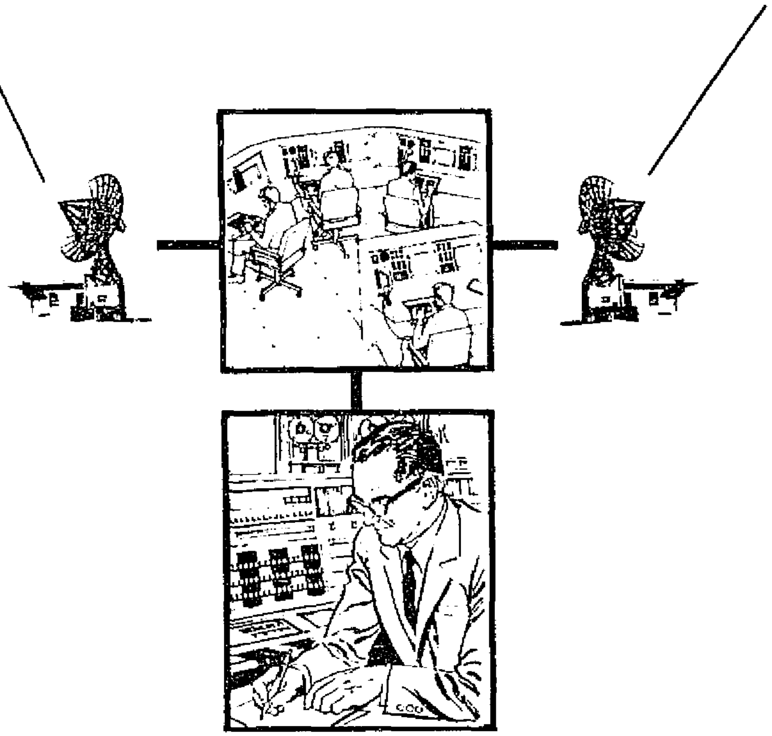

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14 DECEMBER 1976

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BRIEFING OUTLINE

- STUDY BACKGROUND
- REVIEW OF SYSTEM CONCEPTS DERIVED FROM STUDY PHASE A
- SYSTEM CONCEPT REFINEMENT DURING STUDY CONTINUATION, PHASE A-1
- STANDARD POCC IMPLEMENTATION
- IDENTIFICATION OF JOINT ACTIVITIES AND ESTIMATION OF RESOURCES IN PREPARATION FOR JOINT OPERATIONS
- OVERALL STUDY CONCLUSIONS AND RECOMMENDATIONS

STUDY BACKGROUND

STUDY OBJECTIVES

PHASE A

The goal of this study was to develop user oriented STS-Payload Mission Control concepts which provide for optimum contribution of ground flight control support to onboard capability to meet STS-Payload objectives in a cost-effective manner. The specific objectives are those listed on the facing page.

CONTINUATION PHASE A-1

The objectives of the Continuation Phase were to refine selective concepts from the basic study relative to POCC implementation and to identify the major joint activities required for flight preparation and estimate the joint resources necessary to accomplish these activities.

STUDY OBJECTIVES

PHASE A

- IDENTIFY FLIGHT CONTROL GROUND FUNCTIONS FOR REPRESENTATIVE STS PAYLOADS
- INVESTIGATE PRESENT/PLANNED NASA-WIDE FACILITIES (CAPABILITIES) FOR STS PAYLOAD CONTROL
- DETERMINE FEASIBLE COST EFFECTIVE SYSTEM CONCEPT OPTIONS FOR FLIGHT CONTROL OF STS PAYLOADS
- DEVELOP IMPLEMENTATION GUIDELINES FOR PROPOSED SYSTEM CONCEPT OPTIONS

CONTINUATION PHASE A-1

- REFINE CONCEPTS FROM BASIC STUDY INCLUDING:
  - APPROACHES TO POCC IMPLEMENTATION
  - DEFINITION OF INTERFACES, PAYLOAD OPERATOR/STS FLIGHT OPERATOR
- IDENTIFY JOINT PREFLIGHT ACTIVITIES AND ESTIMATE COMPOSITE JOINT RESOURCES

SCOPE OF STUDY

PHASE A

The scope of the Phase A Study was confined to the real-time operational concepts throughout the period from after OFT in 1980 through the fully mature operational phase extending through 1991.

Interfaces between the STS Operator and Payload Operator were stressed and emphasis was placed on determining the existing capabilities of the Centers for application to STS Payloads flight control.

14 representative payload/flight types were selected from the three major classes of Spacelab, Automated Earth Orbiting and Planetary Payload.

CONTINUATION PHASE A-1

The Continuation Study Phase addressed the preflight planning, training and simulations activities beginning from L-2 years and extending to lift-off.

The composite resources for the joint activities associated with preparations for flight operations were estimated during this study phase.

SCOPE OF STUDY

PHASE A

- CONCEPTS FOR STS PAYLOAD REAL-TIME OPERATIONS 1980 THROUGH 1991
- INTERFACES BETWEEN STS PAYLOAD OPERATOR AND STS FLIGHT OPERATOR
- EMPHASIS ON DETERMINING EXISTING NASA CENTERS CAPABILITIES FOR APPLICATION TO STS PAYLOADS
- 14 REPRESENTATIVE PAYLOAD FLIGHT TYPES FROM THREE CLASSES; SPACELAB, AUTOMATED EARTH ORBITING AND PLANETARY PAYLOADS

CONTINUATION PHASE A-1

- PREFLIGHT PLANNING AND FLIGHT PREPARATION INCLUDING TRAINING AND SIMULATIONS
- ESTIMATION OF COMPOSITE RESOURCES FOR PREFLIGHT PLANNING, TRAINING AND SIMULATIONS, 1978 THROUGH 1985

RELEVANT STUDY GUIDELINES

The General Study Guidelines have remained essentially unchanged with the exception of the Flight Traffic Model, which was updated by the COR as of 30 April 1976.

The main thrust of this study effort will address STS Payload Programs during the operational STS Phase.

The existing NASA capabilities, resources and modus operandi will be used as points of departure in performing this study.

Flight support shall be provided in a manner which satisfies the requirements at minimum overall expenditure of resources.

For on-orbit operations during periods when STS has an operational interface with the payload, "flight support" will be jointly provided by MCC/JSC and the responsible Payload Operations Center. ["Flight Support" here includes all functions (tasks) done in support of the on-orbit operations.]

For on-orbit operations during periods when the STS has no operational interface with the payload, "flight support" will be provided by the responsible Payload Operations Center or Agent designated by the responsible payload project office.

RELEVANT STUDY GUIDELINES

- STUDY EMPHASIZES OPERATIONAL ERA (AFTER OFT)
- EXISTING NASA CAPABILITIES ARE POINT OF DEPARTURE FOR THIS STUDY
- PROVIDE FLIGHT SUPPORT TO PAYLOADS WITH MINIMUM EXPENDITURE OF RESOURCES
- ON-ORBIT WHEN STS AND PAYLOAD INTERFACE OPERATIONALLY, FLIGHT OPERATIONS SUPPORT IS PROVIDED JOINTLY BY MCC-H AND A POC
- THE POCC HAS FULL RESPONSIBILITY FOR ITS PAYLOAD DURING FREE-FLIGHT

RELEVANT STUDY GUIDELINES (CONTINUED)

Payload organizations will utilize NASA Control Center host facilities for operations or establish their own Payload Operations Centers where economically justified.

Major NASA Control Centers shall provide host facilities for Customers, or provide appropriate operational interfaces with Customers' remote location with respect to the Control Center, if feasible.

A semi-automated "flight data base" shall be assumed. The "flight data base" need not be in one location so long as means for adequate transfer and interfacing of information between operations centers is provided.

["Flight data base" is the reservoir of all data needed to plan or execute a flight, including system specification values, models, operating constraints, schedules, etc.]

Simplicity of interfaces during launch/landing and during flight among user, developer and operator, and ease of total STS/STS Payload Ground System verification shall be considered as criteria in assessing interfaces and costs.

The study will use the Flight Traffic Model provided by the COR on 30 April 1976 and the same representative flight types and payloads.

RELEVANT STUDY GUIDELINES (CONTINUED)

- USERS UTILIZE NASA HOST FACILITY OR PROVIDE OWN OPERATIONS CENTER
- MAJOR NASA POC'S PROVIDE HOST FACILITIES OR OPERATIONAL INTERFACES WITH CUSTOMERS
- A SEMI-AUTOMATED "FLIGHT DATA BASE" SHALL BE ASSUMED
- INTERFACE SIMPLICITY AMONG USER, DEVELOPER, AND OPERATOR, AND EASE OF SYSTEM VERIFICATION ARE CRITERIA
- STUDY USES UPDATED TRAFFIC MODEL PROVIDED BY THE COR AND SET OF 14 REPRESENTATIVE PAYLOAD FLIGHT TYPES

STUDY TRAFFIC MODEL

This STS Payload Traffic Model Chart combines the payload flight types selected for this study (including Spacelab, Automated Earth Orbit and Planetary) into a traffic model spread from 1980 through 1991. The traffic model presented was provided by the NASA COR on 30 April 1976. The traffic rates approved for this study represent a reduced version (371 flights) of the 572-flight model approved for STS Operations Planning.

This traffic model provides the basis for estimating composite resources required in preflight planning of flight operations, training and simulations.

STUDY TRAFFIC MODEL

	FLIGHT TYPE - PAYLOAD		LEAD PL CENTER	CALENDAR YEAR												TOTAL
	I.D.	DESCRIPTION		80	81	82	83	84	85	86	87	88	89	90	91	
SPACELAB	A	M+P, DC - ATL	LaRC	-	1	1	1	2	3	3	4	4	4	5	5	33
	A'	M+P, DC - OP	GSFC	-	1	1	1	2	2	2	2	2	2	2	2	19
	B	M+P, MD - AMPS, SP	GSFC	-	1	1	2	2	2	2	2	2	2	2	2	20
	B'	M+P, MD - OTHER	GSFC	1	-	-	-	1	1	2	3	3	4	5	6	26
	C	P ONLY, DC - SO	GSFC	-	-	1	1	2	3	5	6	6	5	6	6	41
	C'	P ONLY, DC - STELLAR	GSFC	-	-	-	1	1	1	1	1	1	1	1	1	9
	D	P ONLY, MD - HEA, SEOPS, SO	MSFC	1	1	1	2	3	4	4	4	4	4	4	5	37
	J_1	M ONLY, DD - LS	JSC	-	-	1	1	1	1	1	1	1	1	1	1	10
AUTO EARTH ORBIT	J_2	DELIVERY, MC - EXP, STP (DOD)	GSFC	-	1	1	1	1	1	1	1	1	1	1	1	11
	E	DELIVER - EOS	GSFC	-	1	1	1	-	1	1	1	-	1	-	1	8
	F	DELIVER - ST, RETRIEVE HEAO-C	MSFC	-	-	-	2	2	3	4	3	3	3	4	3	27
	G	REVISIT W/O EVA - EOS	GSFC	-	-	-	-	1	1	-	-	1	-	1	-	4
	H	REVISIT W/EVA - ST	MSFC	-	-	-	1	1	-	1	1	1	1	-	1	7
	I	DELIVER MC - BESS, SEOPS, 2 MINI-LAGEOS, FFTO	ARC	-	-	-	1	1	2	2	2	2	2	1	1	14
	K	MS, IUS - DW, COMSAT	GSFC	-	1	2	3	1	-	-	-	-	-	-	-	7
	M	MS, TUG - TM, INTEL/SAT	GSFC	-	-	-	-	3	5	7	7	10	12	13	11	68
PLANETARY	L	MARINER	JPL	-	1	2	2	2	-	-	-	-	-	-	-	7
	N	PIONEER	JPL	-	-	-	-	-	4	5	6	2	3	1	2	23
	SUBTOTAL, 7-DAY FLIGHTS			2	8	11	19	25	32	38	41	39	41	42	43	341
	SUBTOTAL, 30-DAY FLIGHTS (INCLUDES J_1)			-	-	1	1	1	2	3	3	4	5	5	5	30
	TOTALS			2	8	12	20	26	34	41	44	43	46	47	48	371

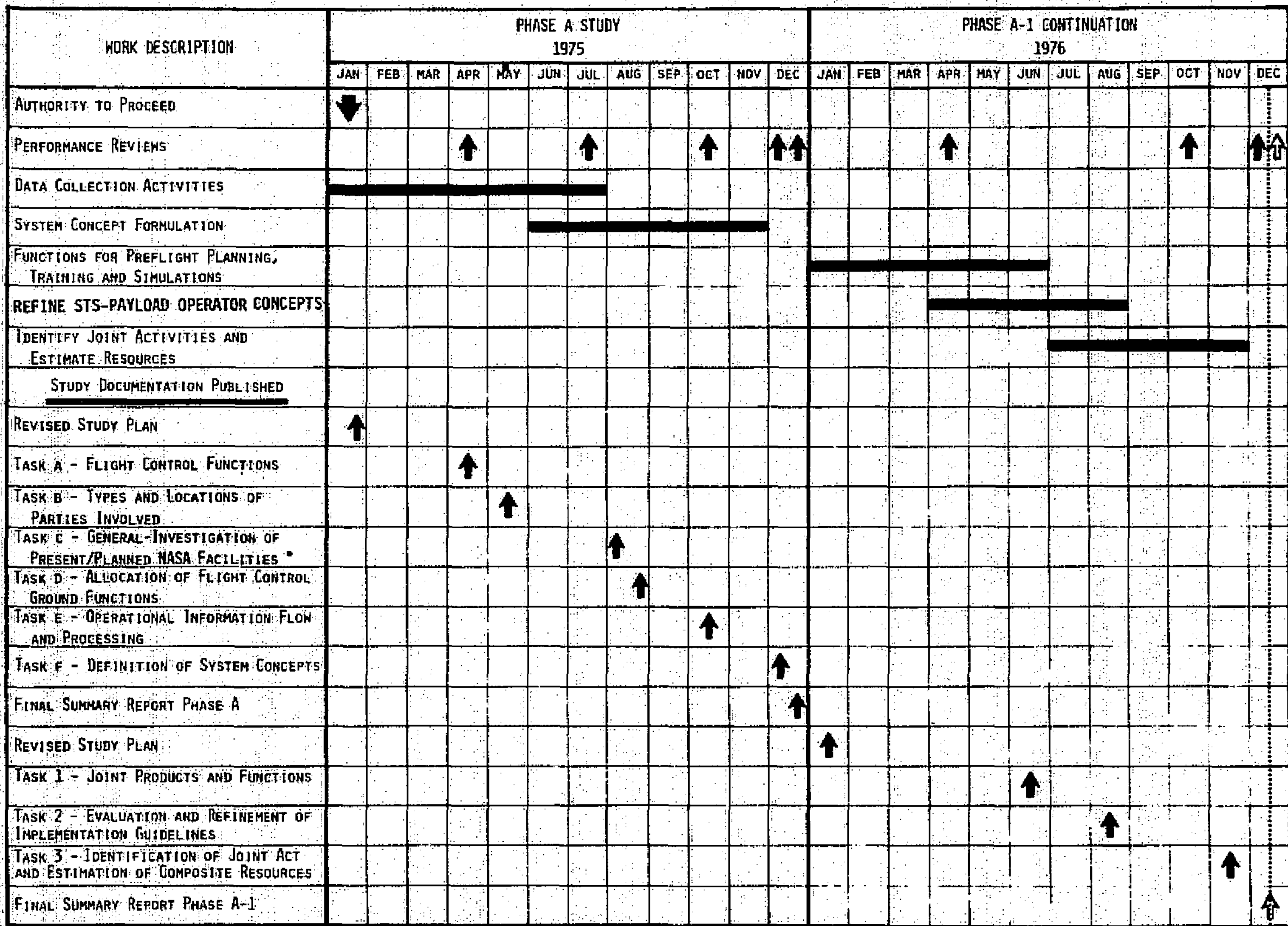
STUDY SCHEDULE

As can be seen from the adjoining schedule, the study began in January 1975 and extends through December 20, 1976, with the Continuation Phase.

The Study Schedule provided for periodic progress reviews and for the incremental delivery of study documentation associated with each study task.

There have been 20 separate study documents delivered in accordance with the documentation schedule listed at the bottom of the facing page. The total documentation including the appendices to the Task C Final Study Document, contains 1650 pages of published study results.

STUDY SCHEDULE



*APPENDICES

A - NASA/ARC CAPABILITIES
B - NASA/GSFC CAPABILITIES
C - NASA/JPL CAPABILITIES
D - NASA/JSC CAPABILITIES
E - NASA/KSC CAPABILITIES
F - NASA/LARC CAPABILITIES
G - NASA/MSFC CAPABILITIES

REVIEW OF SYSTEM CONCEPTS DERIVED FROM PHASE A STUDY

ALTERNATIVES FOR POC LOCATIONS

The adjacent chart shows the initial listing of POC alternatives from which the concepts for STS Payload Flight Control were selected.

These alternatives were based on the following precepts:

a. Utilization of an existing single POC for each class of STS Payloads; Automated Earth Orbiting, Planetary and Spacelab Payloads, respectively.

b. The use of multiple POC's for each class of STS Payload.

c. An alternative in which each NASA Payload Development Center has its own POC for flight control of its payloads.

This matrix of options was used as a point of departure for the development of system concepts.

ALTERNATIVES FOR POC LOCATIONS

MISSION TYPES	EXISTING SINGLE POC	MULTIPLE POC'S	EACH DEVELOPMENT CENTER IS POC
AUTOMATED EARTH ORBIT	GSFC JSC	GSFC, JSC GSFC, MSFC, ARC JSC, MSFC, GSFC	GSFC, MSFC, JSC, ARC, JPL
AUTOMATED PLANETARY	JPL ARC* *REMOTE POC FOR PIONEER	JPL, ARC	JPL, ARC, LaRC
SPACELAB	JSC JPL GSFC	JSC, MSFC JSC, JPL JSC, GSFC JSC, JPL, GSFC JSC, JPL, GSFC, MSFC	JSC, JPL, MSFC, GSFC, ARC, LaRC

JOINT STS-PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. 1

The concept option shown in the adjacent diagram has the following features:

a. It meets initial requirements for control of STS-Payloads at minimum cost.

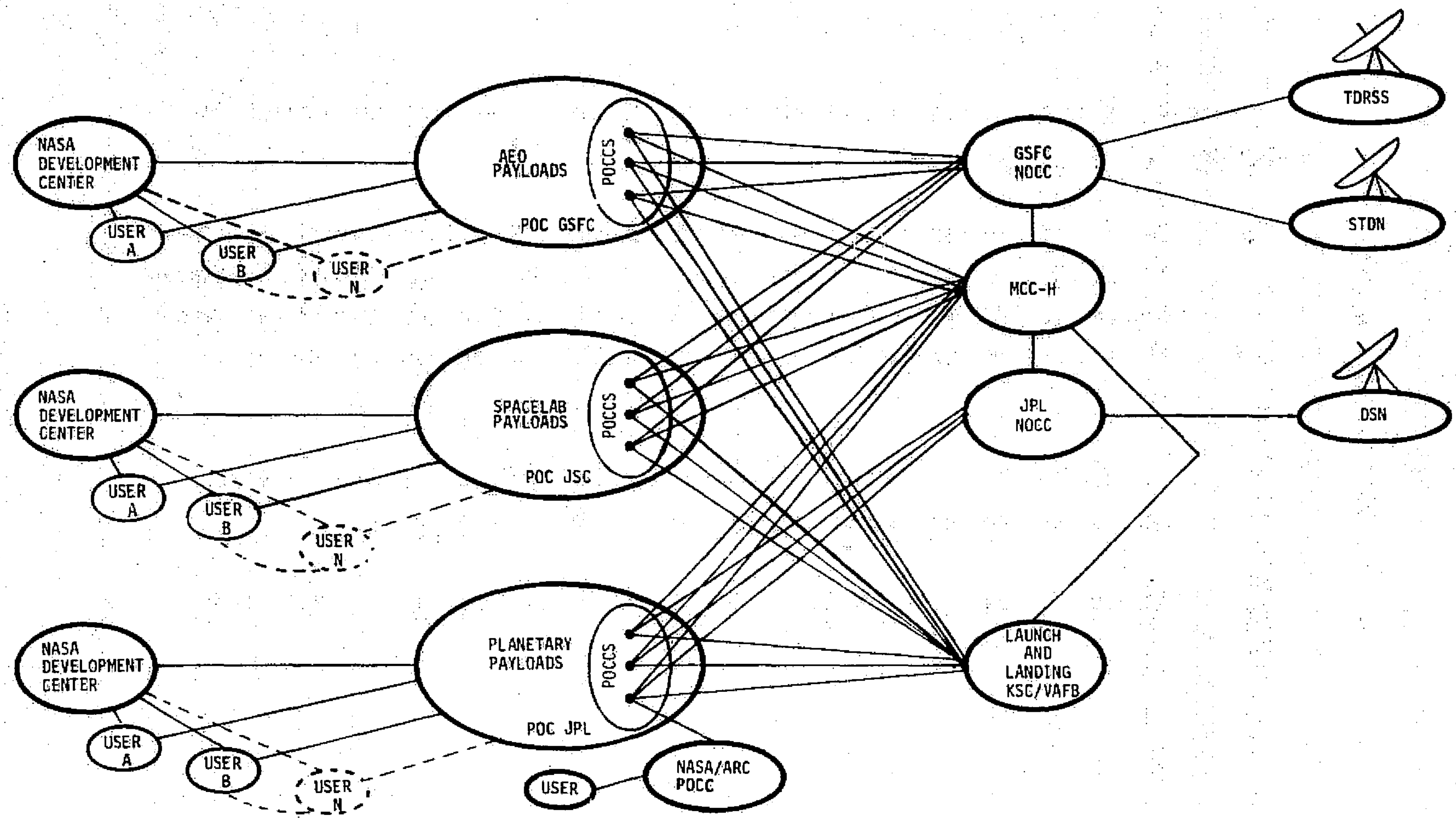
b. It makes maximum use of Centers' existing capabilities and experience.

c. It requires minimum changes to the present mode of payload operations.

d. It provides a solid baseline for future expansion and for system enhancements

e. It will provide for easy transition from present payload operations to STS-Payload operations.

JOINT STS-PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. 1



JOINT STS-PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. 2

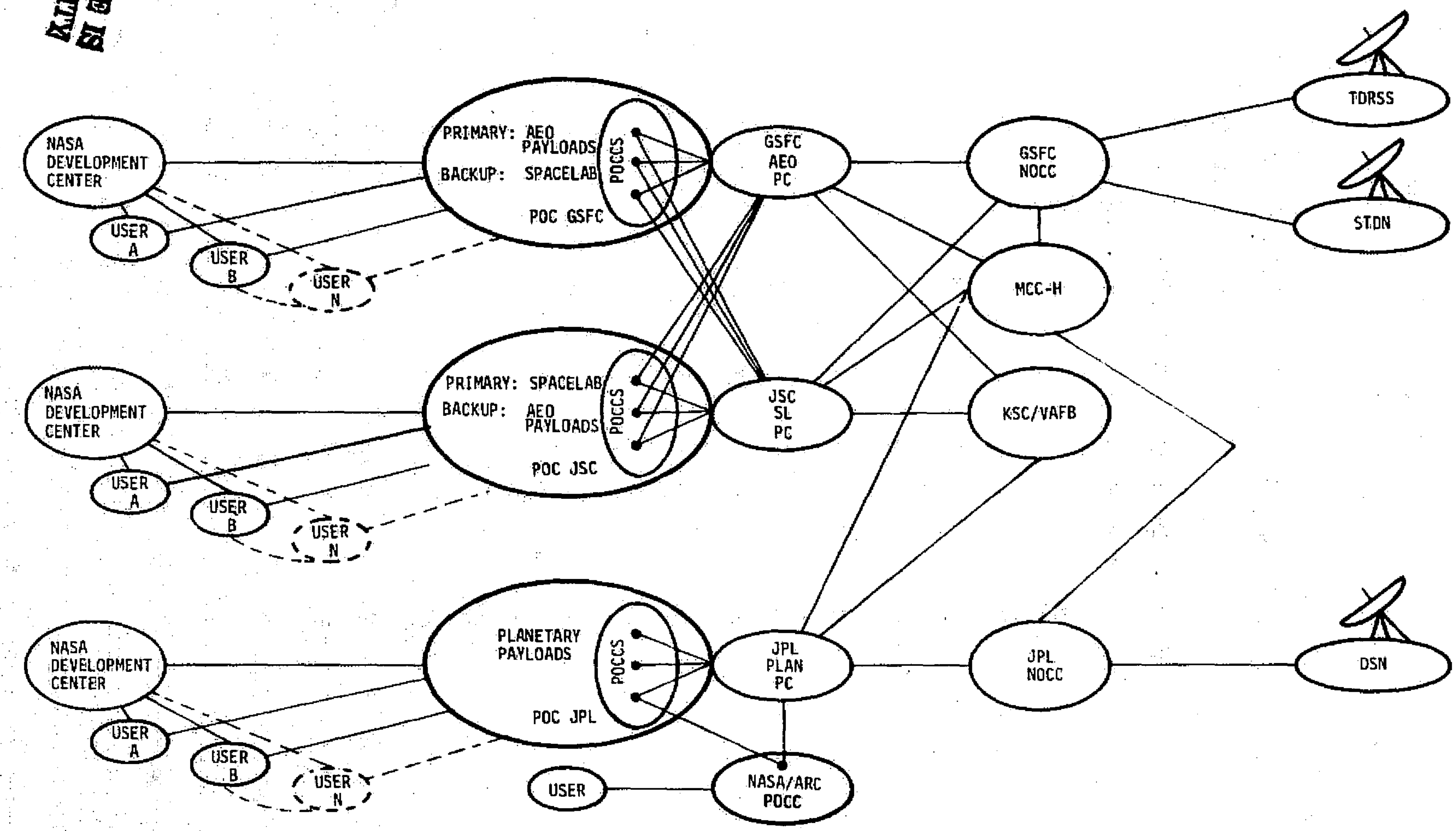
Concept Option No. 2 contains the following additional features beyond those of Option No. 1.

a. A Payload Coordinator has been added to coordinate payload operations within each class of payloads. This reduces the number of operational interfaces between the STS Operator and the payload projects when problems arise which affect STS Joint Operations requiring resolution among the payload projects.

b. A higher level of standardization of operational procedures among the payloads of a given class can be achieved with this concept.

c. Increased versatility for Spacelab and AEO Payload operation is achieved.

JOINT STS-PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. 2



JOINT STS-PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT OPTION NO. 3

System Concept Option No. 3 is envisioned for the period of mature STS Operations when the Payload Traffic Model reaches its maximum level of activity. The additional features of this concept include:

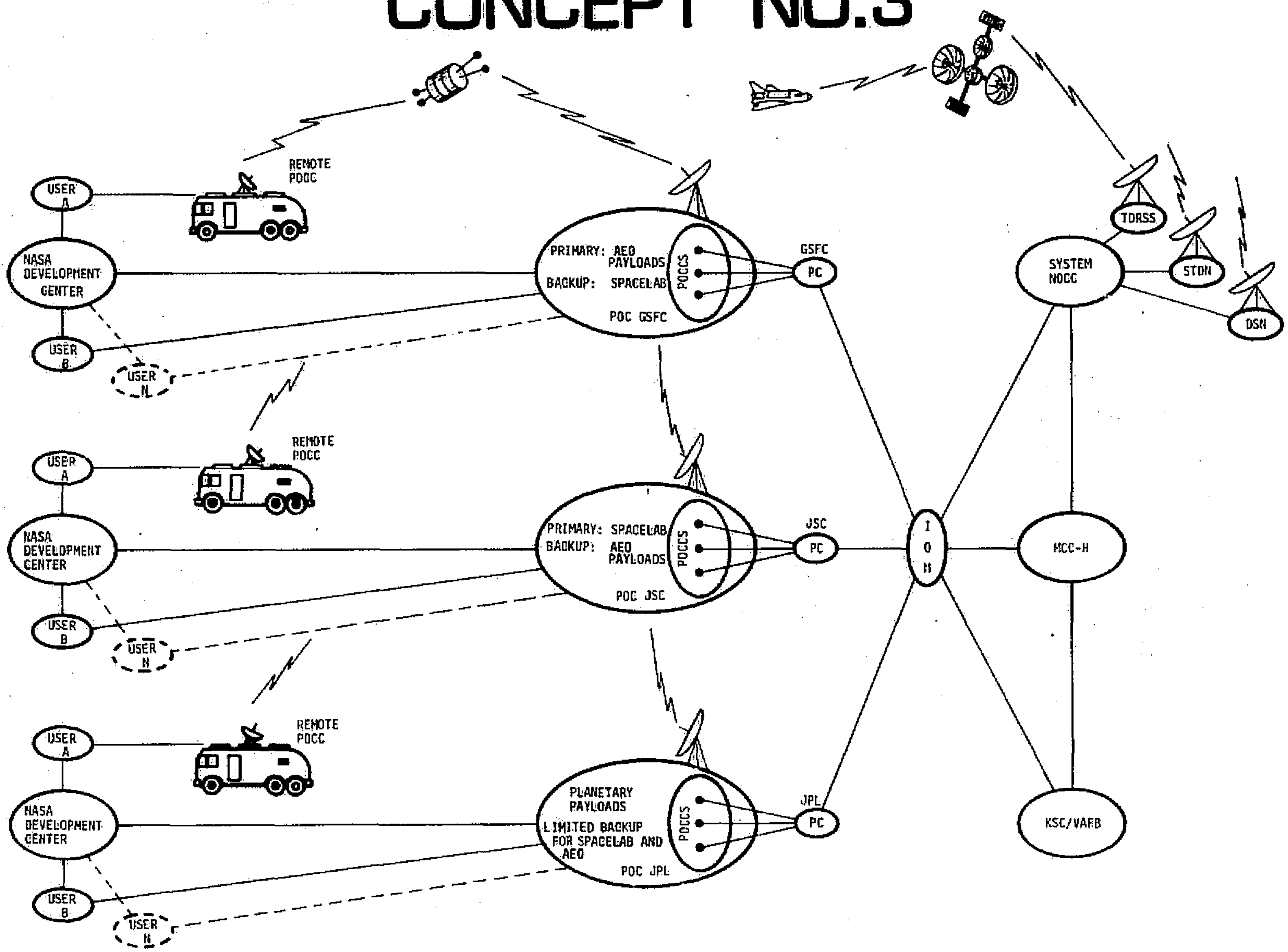
a. It provides for use of efficient remote POCC's.

b. It operates in conjunction with an integrated network control (System NOCC).

c. The addition of an Integrated Operations Manager (IOM), presents a single standard payload interface to MCC-H, System NOCC and the Launch/Landing Sites for resolution of certain payload problems.

d. It accommodates standard operational procedures/conventions in an optimum way.

JOINT STS-PAYLOAD FLIGHT CONTROL SYSTEM CONCEPT NO.3



COMPARISON OF CONCEPT OPTION FEATURES

The facing chart is a matrix which summarizes the comparative features of the three system concept options.

It should be noted under the column "Payload - STS Operations Interface", that POCC's always handle their day to day routine operational matters directly with other operational elements. The PC's and the IOM do not become involved in routine day to day operations. They resolve problems which develop at a higher level and which involve more than one payload.

The last column provides an indication of the system implications imposed by each of the various concept options. System Implications, are those matters which interact with more than one NASA Center or which involve the networks, communications, or other resources which impact all of the centers.

COMPARISON OF CONCEPT OPTION FEATURES

CONCEPT OPTION	PAYLOAD CLASS SUPPORT CAPABILITY	PAYLOAD - STS OPERATIONS INTERFACE	POCC TYPE	SYSTEM IMPLICATIONS
No. 1	GSFC - AEO JSC -- SPACELAB JPL - PLANETARY	DIRECT; INDIVIDUAL POCC'S TO OPERATIONAL ELEMENTS	DEDICATED.	NEW POCC'S FOR SPACELAB SHOULD BE DESIGNED FOR FUTURE STANDARDIZATION WITH OTHER POCC'S
No. 2	GSFC - PRI: AEO BACKUP: SPACELAB JSC - PRI: SPACELAB BACKUP: AEO JPL - PRI: PLANETARY	DIRECT FOR ROUTINE OPERATIONS. INDIVIDUAL POCC'S TO OPERATIONAL ELEMENTS. P.C. TO HANDLE PROBLEMS AFFECTING MULTIPLE PAYLOADS OF A CLASS.	LIMITED STANDARDIZATION. STD FOR JOINT OPS. UNIQUE MODULES FOR FREE-FLYERS	PAYLOAD DESIGN STANDARDS. COMMUNICATIONS SYSTEMS STANDARDS. STANDARDIZED USER INTERFACES. POCC OPERATIONS STANDARDS. SUPERVISORY DATA BASE SYSTEM.
No. 3	GSFC - PRI: AEO BACKUP: SPACELAB JSC - PRI: SPACELAB BACKUP: AEO JPL - PRI: PLANETARY LIMITED BACKUP: SPACELAB & AEO	DIRECT FOR ROUTINE OPERATIONS. INDIVIDUAL POCC'S TO OPERATIONAL ELEMENTS. P.C. TO HANDLE PROBLEMS AFFECTING MULTIPLE PAYLOADS OF A CLASS. IOM TO HANDLE PROBLEMS AFFECTING MULTIPLE PAYLOAD CLASSES.	LIMITED STANDARDIZATION. STD FOR JOINT OPS. UNIQUE MODULES FOR FREE-FLYERS STANDARD PORTABLE POCC'S.	STANDARD DATA PROCESSING AND OPERATING SYSTEMS. DOMSATS FOR WIDEBAND COMM. INTEGRATED NETWORK CONTROL. SYSTEM OPERATING STANDARDS.

FUNCTIONS OF PAYLOAD COORDINATORS, (PC'S) FOR EACH PAYLOAD CLASS

The Payload Coordinator should reside at each Payload Operations Center and coordinate external STS operational problems for all payloads of a given class.

The PC will coordinate between POCC's and Centers when conflicts in the use of resources arise.

By participating in operational planning, the PC can help to insure standardization of operational procedures from payload-to-payload or flight-to-flight.

He provides a single point contact with the IOM or the STS Operator for resolution of problems within a payload class.

He resolves conflicts of resources between payload programs.

Where contingencies arise which affect two or more payloads, the PC can assist in the resolution of these matters.

The PC will have a staff which maintains the schedules and status of all operations within a given payload class.

FUNCTIONS OF PAYLOAD COORDINATORS. (PC'S) FOR EACH PAYLOAD CLASS

- FUNCTION RESIDES AT POC FOR EACH PAYLOAD CLASS
- COORDINATES OPERATIONS BETWEEN CENTERS AND POCC'S FOR ALL PAYLOADS OF A GIVEN CLASS
- INSURES STANDARDIZATION OF OPERATIONS FROM FLIGHT TO FLIGHT
- PROVIDES SINGLE POINT INTERFACE WITH STS OPERATOR FOR PAYLOAD CLASS
- RESOLVES CONFLICTS OF RESOURCES REQUIREMENTS BETWEEN PAYLOAD PROGRAMS
- ASSISTS IN RESOLVING CONTINGENCIES AFFECTING TWO OR MORE PAYLOADS
- MAINTAINS SCHEDULE AND STATUS OF ALL OPERATIONS OF A GIVEN PAYLOAD CLASS

FUNCTIONS OF THE PAYLOAD INTEGRATED OPERATIONS MANAGER (IOM)

The IOM is located at JSC and represents the payload world.

He provides the interface between the Payload Operators and NASA Headquarters during the real-time operation.

He assures that the STS Operator obtains the necessary assistance from payload projects during integrated flight planning and he monitors the integrated flight plan during execution.

The IOM assists in resolving contingency operations between the three payload classes.

He insures standardization of procedures and formats for operational interfaces affecting more than one class of payloads.

He assists in resolving conflicts of resources between payload classes during real-time operations.

His staff maintains schedules and status on all payloads and assesses the impact of real-time operational changes or other scheduled operations.

FUNCTIONS OF THE PAYLOAD INTEGRATED OPERATIONS MANAGER (IOM)

- LOCATED AT JSC BUT NOT ORGANIZATIONALLY ATTACHED
- PROVIDES THE REAL-TIME PAYLOAD OPERATIONAL INTERFACE WITH NASA HEADQUARTERS
- ASSISTS STS FLIGHT OPERATOR IN INTEGRATED FLIGHT PLANNING
- MONITORS INTEGRATED FLIGHT PLAN DURING EXECUTION
- RESOLVES CONTINGENCY OPERATIONS BETWEEN PAYLOAD CLASSES
- INSURES STANDARDIZATION OF PROCEDURES AND FORMATS FOR OPERATIONAL INTERFACES OF ALL PAYLOAD CLASSES
- RESOLVES CONFLICTS OF REQUIREMENTS BETWEEN PAYLOAD CLASSES DURING REAL-TIME OPERATIONS
- MAINTAINS SCHEDULE AND STATUS ON ALL PAYLOADS AND ASSESSES IMPACT OF REAL-TIME OPERATIONAL CHANGES ON OTHER SCHEDULE OPERATIONS

BRIEF SUMMARY OF PHASE A STUDY

In order to make maximum use of existing NASA capabilities, an evolutionary approach to an integrated standardized multi-center system of POCC's is necessary. The implementation plan to achieve such standardization should account for the normal wear out cycle of existing systems and phase-in standardized replacements in an orderly fashion.

A system involving standard POCC's with the capability to support any payload on a quick turn-around basis will provide a higher utilization factor for POCC's and reduce the total number of POCC's required for STS payload support.

If the concept of standard POCC's is adopted it will be necessary to establish early requirements for payload operational standards. This requirement should be phased in gradually over a considerable period of time so as not to impact payload designs presently under way. At the same time, standards should be defined early so as to permit NASA to negotiate them into new payload designs during the formulative stages of the various programs.

A key decision to be made as early as possible is whether to expand the capabilities of the three baseline centers to support all payloads or augment the capability of additional centers to support the increasing load during later phases of the STS Payload era.

A major stride in system enhancement for the users will be the introduction of portable POCC/DOMSAT Terminals to provide wideband communications and control capability for remote users or additional centers as an extension of the POCC at one of the baseline centers.

BRIEF SUMMARY OF PHASE A STUDY

- AN EVOLUTIONARY APPROACH TO AN INTEGRATED, STANDARDIZED MULTI-CENTER SYSTEM FOR FLIGHT CONTROL OF STS PAYLOADS IS INDICATED DURING JOINT STS PAYLOAD OPERATIONAL FLIGHT PHASES.

- THE ULTIMATE SYSTEM PROVIDES REASONABLE STANDARDIZATION OF POCC'S FOR ALL PAYLOADS.

- AN EARLY PROGRAM IS NEEDED TO ESTABLISH STANDARDS FOR STS PAYLOADS.

- AN EARLY KEY DECISION NEEDED IS WHETHER TO EXPAND THE TRI-CENTER, GSFC/JSC/JPL, SYSTEM OR EQUIP ADDITIONAL CENTERS.

- A PORTABLE, INTERACTIVE POCC DOMSAT TERMINAL APPEARS TO BE A PRACTICAL MODE OF OPERATION FOR SPECIFIC USERS.

SYSTEM CONCEPT REFINEMENTS DURING STUDY CONTINUATION

APPROACH TO REFINEMENT OF POCC STANDARDIZATION CONCEPT

To determine the extent to which a Standard POCC would be practical, all flight control functions for the 14 payload/flight types were reviewed to determine which could be handled in a standard manner from payload to payload and which would require unique support from a POCC.

Following this a series of conceptual POCC design configurations were examined. The result of this effort was a functional modularized POCC architecture which allowed the hardware and software to be assembled in functional modules.

The study team reexamined the initial approach to a fully Standard POCC implementation to develop a more practical implementation leading to an optimally Standard POCC which could interface with non-standard user modules via a standard interface approach.

APPROACH TO REFINEMENT OF POCC STANDARDIZATION CONCEPT

- REVIEWED PAYLOAD FLIGHT CONTROL FUNCTIONS IN DETAIL FOR ADAPTABILITY TO STANDARD VERSUS UNIQUE POCC SUPPORT

- INVESTIGATED POCC STANDARDIZATION CONCEPTUAL DESIGN ALTERNATIVES

- DEVELOPED CONCEPTUAL POCC FUNCTIONAL ARCHITECTURE

- REEXAMINED IMPLEMENTATION APPROACH TO A COST EFFECTIVE EVOLUTIONARY SYSTEM TO ACHIEVE REASONABLE LEVEL OF POCC STANDARDIZATION

SYSTEM IMPLICATIONS OF THE STANDARD POCC CONCEPT

Steps similar to those taken by GSFC to develop the Multi-mission Modular Spacecraft (MMS), should be extended to all classes of payloads at the earliest practical time. This would make standardization of ground flight control systems much more easily achieveable and would reap large benefits in cost savings.

Another major cost savings will occur when new schedules are effective for Domestic Satellite Wideband Communications such that large quantities of data can be transmitted point to point in real-time.

A supervisory data base management system is necessary to insure that STS-Payload data is maintained current, that unnecessary redundancy is eliminated and that data can be rapidly accessed from one system element to another.

Once the Standard POCC is a reality, there will be a need for a single central authority for control of all NASA tracking and data acquisition resources.

Operations will be greatly simplified if POCC's all utilize standard operational interfaces with other STS operational elements such as the MCC-H, Launch and Landing Sites, Networks, Users, and the various science and engineering support teams supporting the payload operations.

SYSTEM IMPLICATIONS OF THE STANDARD POCC CONCEPT

- EARLY IMPLEMENTATION OF PAYLOAD STANDARDS AND CONVENTIONS REQUIRED
- LOW COST POINT TO POINT COMMUNICATIONS
- DIRECT COMPUTER TO COMPUTER COMMUNICATIONS BETWEEN POC'S
- SUPERVISORY DATA BASE MANAGEMENT SYSTEM
- INTEGRATED NETWORK OPERATIONS CONTROL CENTER (NOCC)
- STANDARD EXTERNAL INTERFACES FOR POCC'S WITH
  - MCC-H
  - LAUNCH/LANDING SITES
  - NETWORKS
  - USERS
  - SCIENCE ANALYSIS SUPPORT TEAMS
  - ENGINEERING ANALYSIS SUPPORT TEAMS

FUNCTIONAL STANDARDIZATION ANALYSIS

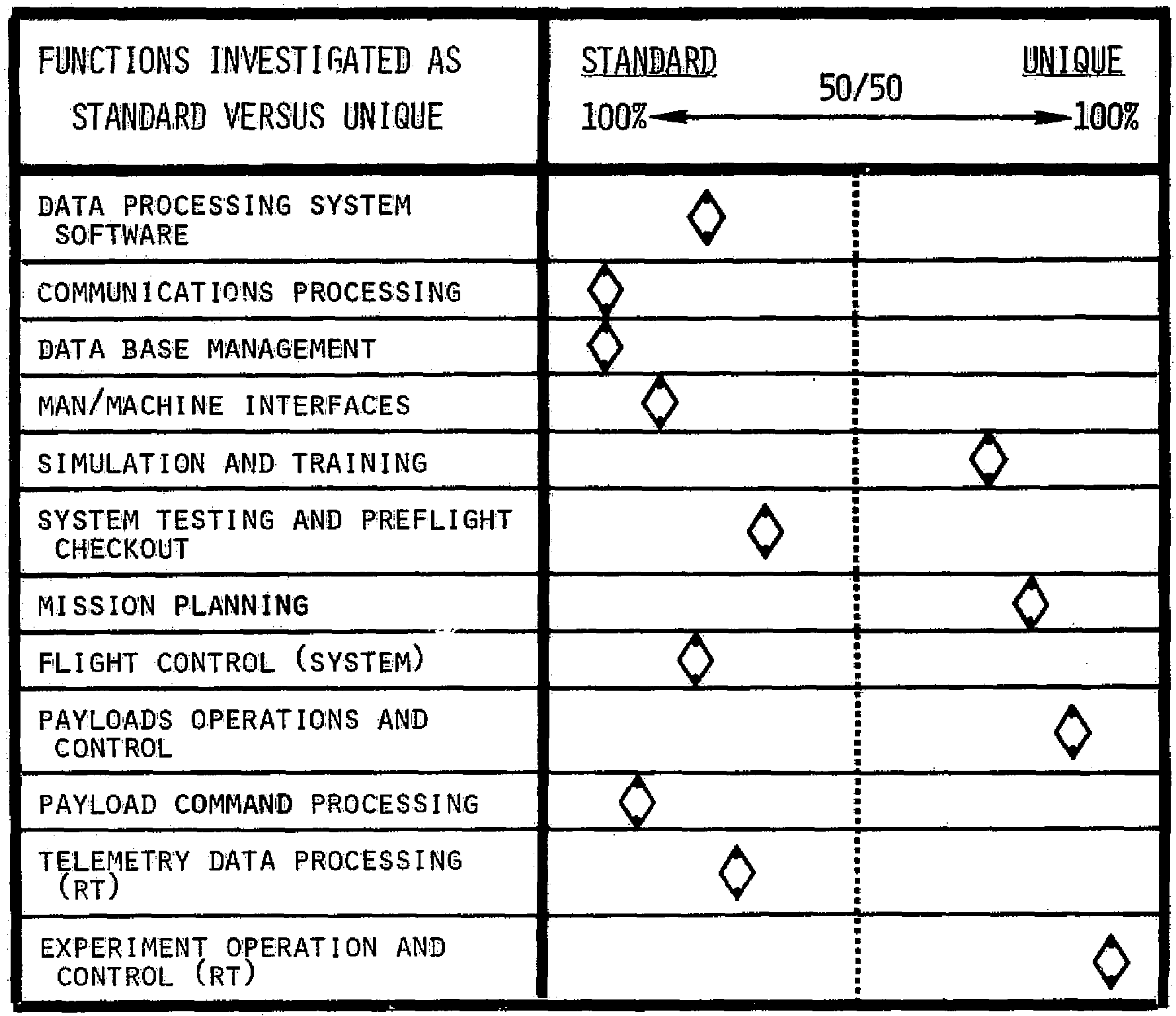
The chart on the facing page shows on a general scale, the extent of standardization versus uniqueness achieveable for each of the selected POCC functions which were investigated.

For example, the processing of data can be done to a very high degree of standardization in accordance with prior instructions, although it is recognized that the analysis of processed data may be highly unique and may have to be done off-line by highly specialized personnel.

Functions such as communications processing, data base management, man/machine interfaces, system test and checkout, system flight control and payload telemetry and command processing can be made to have a high degree of similarity in their methods of handling within a POCC.

Conversely, some functions such as simulation and training, mission planning, payload operations and control, and experiment operation and control will always have a high content of unique or mission peculiar characteristics.

FUNCTIONAL STANDARDIZATION ANALYSIS



POCC STANDARDIZATION ALTERNATIVES

The chart shows three alternatives for implementing various levels of standardization among the POCC's for each center.

The first column depicts a set of dedicated POCC's for each Center where all POCC's of a given Center would have standard capability to which the necessary unique capabilities would be added to accommodate the special requirements of the individual payloads within the class of payloads supported by the POCC's.

The second column depicts limited standardization where each Center has Standard POCC's for all standard functions and where GSFC and JSC have unique but identical support modules to support the non-standard functions of both classes of payloads. JPL only, would have the capability to support the unique Planetary Flight Control functions.

The third column shows the concept of full standardization where each Center would have identical standard POCC's with a full range of capabilities to support the unique functions of any class of payloads.

The concept of limited standardization in the center column is the recommended approach.

POCC STANDARDIZATION ALTERNATIVES

POC	DEDICATED POCC'S	LIMITED STANDARDIZATION	FULL STANDARDIZATION
JSC	STANDARD POCC'S ALL SPACELAB PAYLOADS MISSION UNIQUE SPACELAB FUNCTIONS	STANDARD POCC'S ALL SPACELAB AND AEO PAYLOADS MISSION UNIQUE SPACELAB FUNCTIONS MISSION UNIQUE AEO FUNCTIONS	STANDARD POCC'S ALL SPACELAB AEO AND PLANETARY PAYLOADS MISSION UNIQUE SPACELAB FUNCTIONS MISSION UNIQUE AEO FUNCTIONS MISSION UNIQUE PLANETARY FUNCTIONS
GSFC	STANDARD POCC'S ALL AUTOMATED EARTH ORBITING PAYLOADS MISSION UNIQUE AEO FUNCTIONS	STANDARD POCC'S ALL AEO AND SPACELAB PAYLOADS MISSION UNIQUE AEO FUNCTIONS MISSION UNIQUE SPACELAB FUNCTIONS	STANDARD POCC'S ALL AEO SPACELAB AND PLANETARY PAYLOADS MISSION UNIQUE AEO FUNCTIONS MISSION UNIQUE SPACELAB FUNCTIONS MISSION UNIQUE PLANETARY FUNCTIONS
JPL	STANDARD POCC'S ALL PLANETARY PAYLOADS MISSION UNIQUE PLANETARY FUNCTIONS	STANDARD POCC'S ALL PLANETARY PAYLOADS LIMITED BACKUP AEO AND SPACELAB MISSION UNIQUE PLANETARY FUNCTIONS	STANDARD POCC'S ALL PLANETARY SPACELAB AND AEO PAYLOADS MISSION UNIQUE PLANETARY FUNCTIONS MISSION UNIQUE AEO FUNCTIONS MISSION UNIQUE SPACELAB FUNCTIONS

CONCEPT OF LIMITED STANDARDIZATION WITH BACKUP CAPABILITY

Following an in-depth analysis of all the flight control functions which were interpreted for ground control by the Payload Operator at the POCC's, it was concluded that limited standardization with some backup capability among the POCC's was the optimum solution.

The facing chart shows the concept of full backup capability between GSFC and JSC for Spacelab and Automated Earth Orbiting POCC's and backup by JPL for the Standard POCC functions in support of both AEO and Spacelab Payloads. Because of the unique characteristics of Planetary Flight Control, it was not considered feasible for JSC or GSFC to backup JPL in the control of Planetary Payloads.

CONCEPT OF LIMITED STANDARDIZATION WITH BACKUP CAPABILITY

ANALYSIS RESULTED IN CONCLUSION THAT LIMITED STANDARDIZATION WITH BACKUP CAPABILITY IS OPTIMUM SOLUTION

POC'S	SPACELAB	AEO	PLANETARY
GSFC	FULL BACKUP	PRIMARY	-------
JSC	PRIMARY	FULL BACKUP	-------
JPL	LIMITED BACKUP	LIMITED BACKUP	PRIMARY

NOTE: FULL BACKUP CAPABILITY BETWEEN POCC'S OF ANY SINGLE POC

STANDARD POCC FUNCTIONAL BLOCK DIAGRAM

The Functional Block Diagram shows the functions of the Standard POCC in terms of system support functions and real-time operational functions. Since the off-line function of mission planning interacts with the Standard POCC functions, it is shown interfacing through the POCC Data Base and the real-time operational control functions.

It will be noted that Flight Control, Payload Operations Control and Experiment Operation Control are listed separately. These distinctions have been made in order to categorize functions into standard groupings regardless of the class of payload, i.e., Spacelab, or Free-Flyers.

Flight Control Functions pertain to the Spacelab or a Free-Flyer Spacecraft. An example would be an orientation maneuver. Payload Operational Functions apply to the Payload or composite group of experiments. An Experiment Operation Control Function would pertain to a single experiment or science package.

The support functions include the Man/Machine Interface, Data Base Management, Communications Processing, Status Monitoring, Simulation and Training. All functions are under the control of the Data Processing Operating System.

STANDARD POCC FUNCTIONAL BLOCK DIAGRAM

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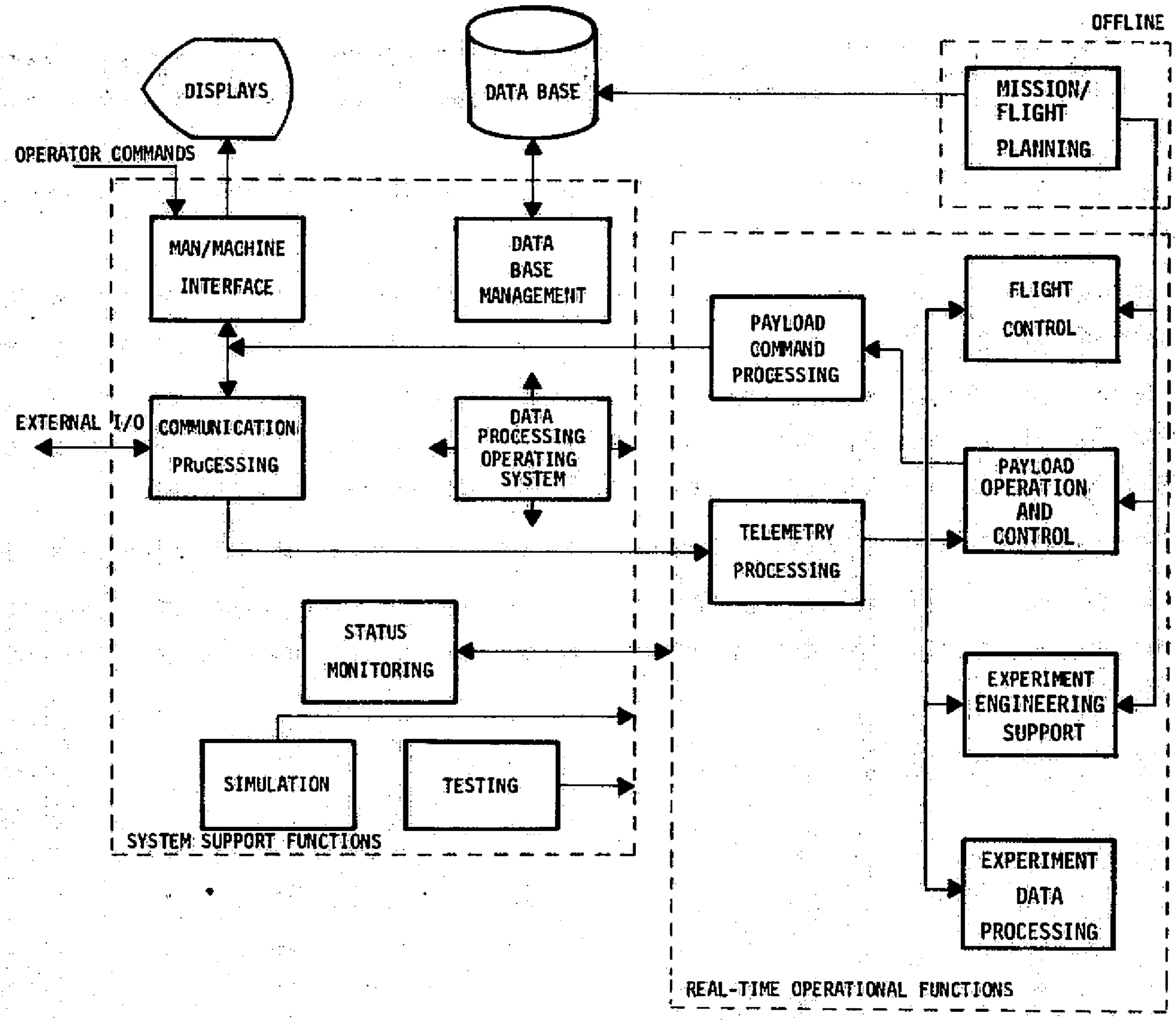


INTERFACING AND OPERATING REMOTE POCC'S

This chart identifies the conceptual capabilities for interfacing and operating the Remote POCC's.

Remote POCC's can provide the same full capability as a POCC located at the POC or can provide any portion of the full capabilities as a particular application may require.

Operational location of a Remote POCC is not a limiting factor as it is planned to provide for either two-way land lines or DOMSAT communications with the POC or a combination consisting of transmitting by land lines and receiving by DOMSAT.

Remote POCC's always operate through the Parent POC or as an extension of a POCC.

Additional support to Remote POCC's can be provided by the Parent POC consisting of payload health and/or science telemetry processing and/or command generation and verification.

INTERFACING AND OPERATING REMOTE POCC'S

- REMOTE POCC'S ARE MODULAR AND MAY HAVE FULL OR PARTIAL CAPABILITY

- CAPABILITIES INCLUDE
  - DATA PROCESSING AND DISPLAY
  - PAYLOAD COMMAND PROCESSING
  - COMMUNICATIONS

- REMOTE POCC'S MAY BE LOCATED ANYWHERE AND MAY BE INTERFACED VIA:
  - LANDLINES
  - DOMSAT LINKS

- REMOTE POCC OPERATIONS:
  - ALWAYS WORK THROUGH PARENT POC OR AS AN EXTENSION OF A POCC
  - WILL BE COORDINATED BY PAYLOAD COORDINATOR FOR OPERATIONS WITHIN A PAYLOAD CLASS
  - MAY RECEIVE ADDITIONAL SUPPORT FROM LOCAL POCC'S
  - MAY PROVIDE SUPPORT FOR SCIENCE ONLY OR COMPLETE PAYLOADS

STANDARD
POCC IMPLEMENTATION

DRIVERS FOR STANDARD POCC IMPLEMENTATION

The six major drivers for Standard POCC implementation as listed on the facing pages are:

1.	Cost	Minimum cost dictates the use of existing facilities for as long as possible. Cost will also be minimized by standardization and as new systems are phased in, standardization can be achieved.
2.	Flight Rate Build-Up	As the traffic model builds toward peak levels the system capabilities should expand to accommodate the load. Based on the traffic model, the logical time phased support capability would seem to be 1980 for the initial capability building toward mid-1983 for implementation of the Standard POCC concept with the necessary versatility to cope with rapidly increasing work loads after that point in time.
3.	Increasing Numbers of Flight Overlaps	Most flight overlaps occur with Planetary and Large complex free-flyer payloads. As overlaps build up, the requirements on data handling capacity and team structures will increase.
4.	Common Payload Interfaces With MCC-H	The focal point during certain flight phases for an increasing number of operational functions will be the interface with MCC-H. Simplification and standardization of interfaces and operating procedures will minimize this impact.
5.	Accommodation of Spacelab Payloads	Spacelab payloads will be the largest single class of payloads to be accommodated. Since these payloads are all short duration (7-30 days), the POCC systems at the various centers should be capable of spacelab payload support with quick turn-around times. Standard POCC's would facilitate this concept.
6.	Increasing User Involvement	As POCC's become more standard, versatility will increase. This will permit a more diverse set of user requirements to be met and with the incorporation of remote POCC's the user can be integrated into the NASA operational environment from his parent facility location.

DRIVERS FOR STANDARD POCC IMPLEMENTATION

• COST	DRIVES TOWARD USE OF EXISTING CAPABILITIES, STANDARDIZATION OF SYSTEMS AND PROCEDURES; SYSTEM VERSATILITY.
• FLIGHT RATE BUILD-UP	SUGGESTS TIME PHASED IMPLEMENTATION; IMPROVED SYSTEM TURN-AROUND TIMES; ENHANCED DATA HANDLING CAPABILITIES.
• INCREASING NUMBERS OF FLIGHT OVERLAPS	CONSIDERATION FOR MULTIPLE RESOURCES FOR DATA HANDLING, COMPUTATION AND TEAM STRUCTURES.
• COMMON PAYLOAD CONTROL INTERFACES WITH MCC-H	DRIVES TOWARD STANDARD OPERATING INTERFACES AND PROCEDURES.
• ACCOMMODATION OF SPACELAB PAYLOADS	SPACELAB PAYLOADS TO BE LARGEST SINGLE CLASS, ALL SHORT DURATION. ALL POCC'S SHOULD BE CAPABLE OF SPACELAB PAYLOAD SUPPORT.
• INCREASING USER INVOLVEMENT	GREATER POCC VERSATILITY. GEOGRAPHICAL DIVERSIFICATION.

POCC IMPLEMENTATION GUIDELINES

IMPLEMENTATION RATIONALE

An evolutionary implementation scheme should be considered to meet initial requirements at minimum cost and to increase the STS Payload operations capability ahead of the expanding requirements. The suggested approach is to start with Concept No. 1 and grow towards Concept No.'s 2 and 3 as system loading increases. This implementation approach to meet the ultimate requirements can be made most cost effective by increasing the efficiency of early system elements rather than adding new elements. This may be achieved through such measures as:

a. System standardization.

b. Improved utilization of facilities and equipment.

c. Added versatility for POCC's to support different payloads.

d. Use of firmware instead of software.

e. Integration of separate functions performing similar tasks.

POCC IMPLEMENTATION GUIDELINES

IMPLEMENTATION RATIONALE

- START WITH EXISTING SYSTEM, CONCEPT NO. 1
- GROW TOWARDS CONCEPTS 2 AND 3 AS SYSTEM LOADING DICTATES
- EMPLOY A TIME PHASED BUILDING BLOCK APPROACH
- MINIMIZE COSTS BY INCREASING SYSTEM EFFICIENCY THROUGH:
  - STANDARDIZATION
  - MODULARIZING POCC FUNCTIONS
  - IMPROVED UTILIZATION
  - POCC VERSATILITY (FAST TURN-AROUND)
  - FIRMWARE VERSUS SOFTWARE
  - INTEGRATION OF SEPARATE CAPABILITIES
- A PRACTICAL APPROACH SUGGESTS EVOLVING FROM PRESENT SYSTEM TOWARD A FULLY INTEGRATED, MULTI-CENTER SYSTEM FOR STS-PAYLOAD SUPPORT

STANDARD POCC IMPLEMENTATION CONCEPTS

Through the use of Domestic Satellite links, either via Remote POCC's or via the POCC communicating directly with a DOMSAT Ground Terminal, the real-time transfer of wideband data will greatly enhance the functions shown on the chart.

Providing standard modular operating consoles for similar functions at each Center, such as those listed on the chart, will not only result in cost savings for the purchase and maintenance of the consoles, but standardization of training and operating procedures will greatly benefit the personnel associated with these functions.

STANDARD POCC IMPLEMENTATION CONCEPTS

- PROVIDE WIDEBAND DATA TRANSFER VIA DOMSATS TO ENABLE:
  - LEVELING COMPUTER LOADS BETWEEN CENTERS
  - REAL-TIME DISPLAY TRANSFER
  - DATA BASE INFORMATION EXCHANGE
  - HIGH SPEED DATAFAX HARD COPY EXCHANGE

- PROVIDE STANDARD MODULAR OPERATING CONSOLES FOR SIMILAR FUNCTIONS AT EACH CENTER
  - STANDARD SPACE FLIGHT CONTROLLERS CONSOLE
  - STANDARD COMMUNICATIONS CONSOLE
  - STANDARD SYSTEM CONFIGURATION CONSOLE WITH REMOTE POCC INTERFACE MODULE
  - STANDARD COMMAND CONSOLE
  - STANDARD DATA PROCESSING AND DISPLAY CONSOLE MODULES, SUCH AS:

    PAYLOAD HEALTH TELEMETRY MODULE
    PAYLOAD SCIENCE TELEMETRY MODULE
    PAYLOAD STATUS AND ALARM PANEL
    PAYLOAD (SPACELAB) CREW MONITOR MODULE
    PAYLOAD GUIDANCE AND NAVIGATION MODULE
    PAYLOAD CONSUMABLES MANAGEMENT MODULE

STANDARD POCC IMPLEMENTATION CONCEPTS (CONTINUED)

The standardization of payload data processing, stripping, formatting and routing, should be accomplished in accordance with User requirements by designated resources. This will not only accelerate the communication of payload data to the user, but will expedite emergency control or orbiting and operating payloads.

Functional support for Standard POCC's for the functions listed should be provided either by the parent POC associated with the POCC or via designated functional support elements within the NASA System.

Because of the projected multi-overlap of satellites operating after the 1982 era, the necessary POCC redundancy sufficient to support multiple missions without mutual interference should be implemented at each POCC.

System architecture should maximize the use of mini-computers in order to provide flexibility and simplify rapid reconfiguration of a POCC from one mission to another.

STANDARD POCC IMPLEMENTATION CONCEPTS (CONTINUED)

- ALL PAYLOAD DATA PREPROCESSING, STRIPPING, FORMATTING AND ROUTING DONE BY DESIGNATED DATA ACQUISITION RESOURCES, PER USER REQUIREMENTS

- CENTRALIZED FUNCTIONAL SUPPORT FOR STANDARD POCC'S WHERE MAJOR RESOURCES ARE REQUIRED
  - VIDEO AND WIDEBAND ANALOG PROCESSING
  - FREE-FLYER EARTH ORBITING TRAJECTORY ANALYSIS AND ORBIT DETERMINATION
  - PLANETARY PAYLOAD TRAJECTORY ANALYSIS AND COMPUTATION
  - SPACELAB TRAJECTORY ANALYSIS AND COMPUTATION
  - DISTRIBUTED DATA BASE SYSTEM UNDER SUPERVISORY CONTROL OF SINGLE CENTER

- POCC'S SHOULD CONTAIN ENOUGH REDUNDANCY TO SIMULTANEOUSLY SUPPORT ONE SHORT JOINT MISSION AND ONE OR MORE LONG DURATION FREE-FLYERS WITHOUT MUTUAL INTERFERENCE

- POCC ARCHITECTURE SHOULD UTILIZE MINI-COMPUTERS FOR SEPARATE FUNCTIONS IN ORDER TO:
  - ELIMINATE THE PROBLEM OF MAINTAINING LARGE COMPLEX SOFTWARE SYSTEMS
  - FACILITATE CUSTOMIZED USER INTERFACES
  - SIMPLIFY POCC INTEGRATION AND PERMIT RAPID RECONFIGURATION

POCC SYSTEM
DEVELOPMENT ACTIVITY NETWORK

This chart shows a summary of the development activity and the interactions between activities on a timeline extending from 1977 through Mid-1982.

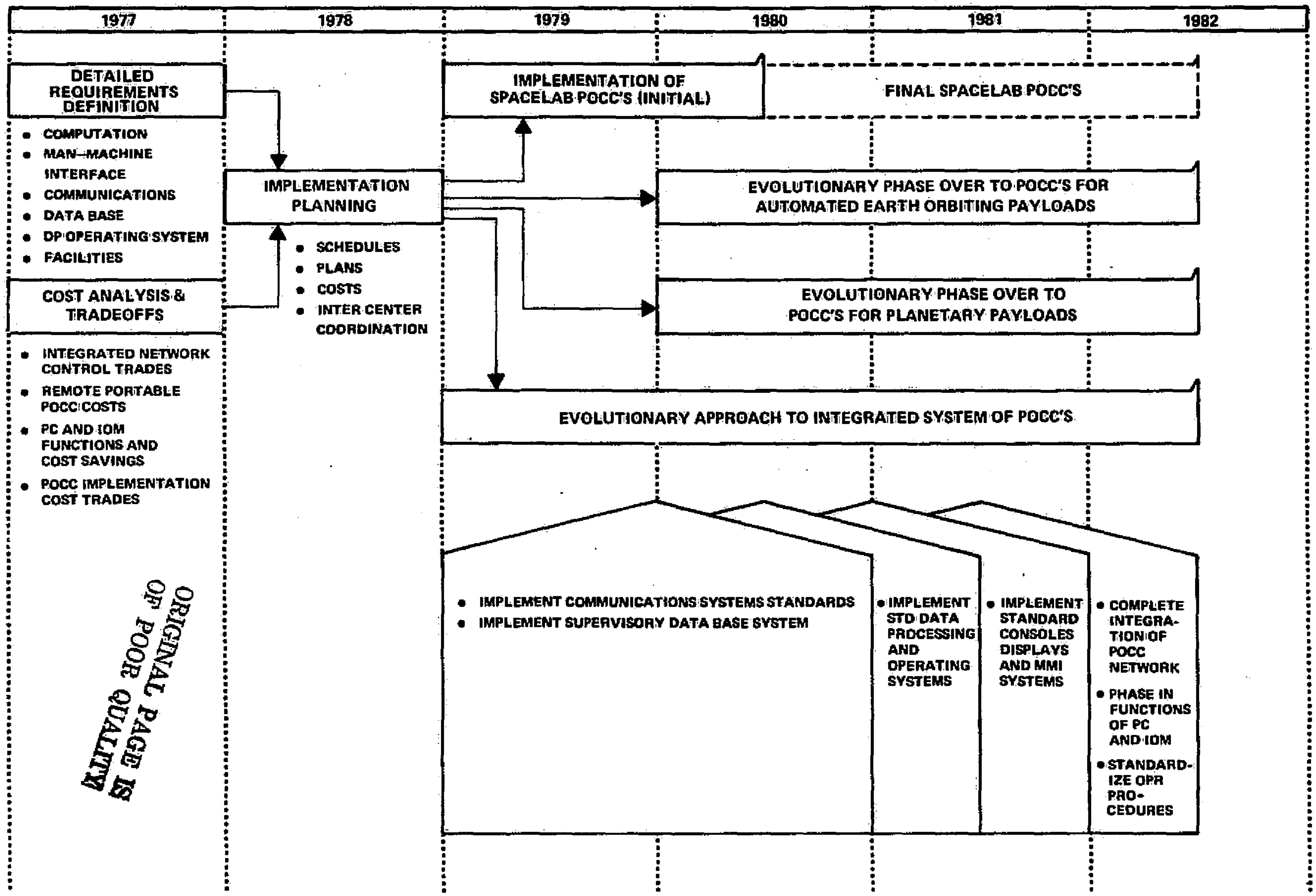
The major thrust of the recommended POCC implementation plan is to reduce ground operating costs through an evolutionary implementation of flexible standard systems of hardware and software for POCC's to be implemented as replacements at the time of the normal equipment generation update period.

The 1977-78 activities involve a detailed requirements definition in parallel with a cost analysis to assess the savings which can result from the Standard POCC approach. It is anticipated that the cost analysis will justify the continued efforts.

The bars extending from 1979 through Mid-1982 depict the implementation phase and show the span of activities for POCC's of each Center (JSC, GSFC and JPL), as well as the span of activities for achieving the integrated system of POCC's.

At the bottom right, the overlapping blocks indicate the general time phasing for augmenting or upgrading the various systems and functions leading to an integrated NASA-wide system of POCC's.

POCC SYSTEM DEVELOPMENT ACTIVITY NETWORK



MAJOR CHARACTERISTICS OF THE STANDARD POCC SYSTEM DEVELOPMENT

In summary, the major features of the Standard POCC approach are:

a. To integrate the necessray resources from all three Centers into an overall system for support of STS-Payloads.

b. To follow an evolutionary implementation scheme where the best features of each center are retained and enhanced as necessary to formulate a standard implementation for all centers.

c. To implement standardization only to the extent practical and to carefully examine the gains resulting from each new step in the direction of standardization versus the retention of specific unique capabilities.

MAJOR CHARACTERISTICS OF THE STANDARD POCC SYSTEM DEVELOPMENT

- INTEGRATE RESOURCES FROM THREE CENTERS INTO OVERALL SYSTEM OF STANDARD POCC'S

- EVOLUTIONARY IMPLEMENTATION SCHEME

  CONCEPT 1 → CONCEPT 2 → CONCEPT 3

  RESULTING IN A GRADUAL PHASE-OUT OF EXISTING SUBSYSTEMS AND PHASE-IN OF NEW SOFTWARE, HARDWARE AND PROCEDURES

- PARTIAL STANDARDIZATION RECOMMENDED -- I.E., JSC, GSFC AND JPL CAPABLE OF HANDLING ANY SPACELAB PAYLOAD, GSFC AND JSC, ANY AEO PAYLOAD AND JPL, ANY PLANETARY PAYLOAD

IDENTIFICATION OF JOINT ACTIVITIES AND ESTIMATION OF RESOURCES IN PREPARATION FOR JOINT OPERATIONS

SPECIAL GUIDELINES FOR IDENTIFICATION OF JOINT ACTIVITIES AND RESOURCES ESTIMATION

The following guidelines apply for identification of joint activities and resources estimation.

a. Only those activities that involve joint participation of STS and Payload organizational elements are addressed.

b. The activity period addressed in this part of the study is limited to the pre-launch period from two years before launch through committment for launch, just prior to lift-off.

c. The study addresses Operational-Era Flights only, defined as all flights after six Orbital Flight Tests (OFT's), i.e., period 1980-1991, however, resources are estimated only through 1985 Flights.

d. The study addresses preparations for Flight Operations only (including flight planning, training and simulations), but does not address Ground Operations at the Launch and Landing Sites.

e. An "assembly-line" approach will be followed when appropriate, whereby interactive activities accomplished interactively on each flight will be repeated with same people flight-to-flight and payload-to-payload.

f. Personnel included in the activity man-loading estimates of Task 3 are professional personnel only, from all necessary organizations/functions involved in the joint tasks, rounded to the nearest integer.

SPECIAL GUIDELINES FOR IDENTIFICATION OF JOINT ACTIVITIES AND RESOURCES ESTIMATION

- ONLY JOINT ACTIVITIES ADDRESSED IN STUDY
- PERIOD OF ACTIVITY, L-2 YEARS TO LAUNCH COMMIT
- OPERATIONAL ERA FLIGHTS - AFTER OFT THROUGH 1991. RESOURCES ESTIMATED ONLY THROUGH 1985 FLIGHTS
- STUDY ADDRESSES PREPARATIONS FOR FLIGHT OPERATIONS, NOT GROUND OPERATIONS AT LAUNCH/LANDING SITES
- AN "ASSEMBLY LINE" APPROACH TO FLIGHT PLANNING WILL BE USED AS APPROPRIATE
- ONLY PROFESSIONAL PERSONNEL INCLUDED IN RESOURCES ESTIMATES

STUDY ACTIVITY FLOW FOR PREFLIGHT PREPARATION AND RESOURCES ESTIMATION

The flow chart on the right shows the steps necessary to establish the requirements for composite resources to support joint preflight activities.

Having defined 25 joint preflight activities, the next step was to determine the general sequence of activity which begins at two years prior to launch.

Next, the organizational elements or functional groups required to conduct the various activities were identified and each of the 25 activities was allocated to one of the functions for primary responsibility and to the various functions for support, inputs and/or review.

The modified study traffic model shown in the Continuation Phase Study Plan was used as the model to determine the number of payloads of each type to be flown each year from 1980 through 1991.

The 25 activities were timelined, based on estimated times required for the initial planning activity cycles ranging from least complex to the most complex payloads of each class. Based on this data, experience factors were then estimated for repeat flights after the first, third and tenth flight of a given category.

The final steps involve overlaying activity spans for all flights of a given type for each year on a month to month timeline. From this data, the joint resources can then be established.

STUDY ACTIVITY FLOW FOR PREFLIGHT PREPARATION AND RESOURCES ESTIMATION

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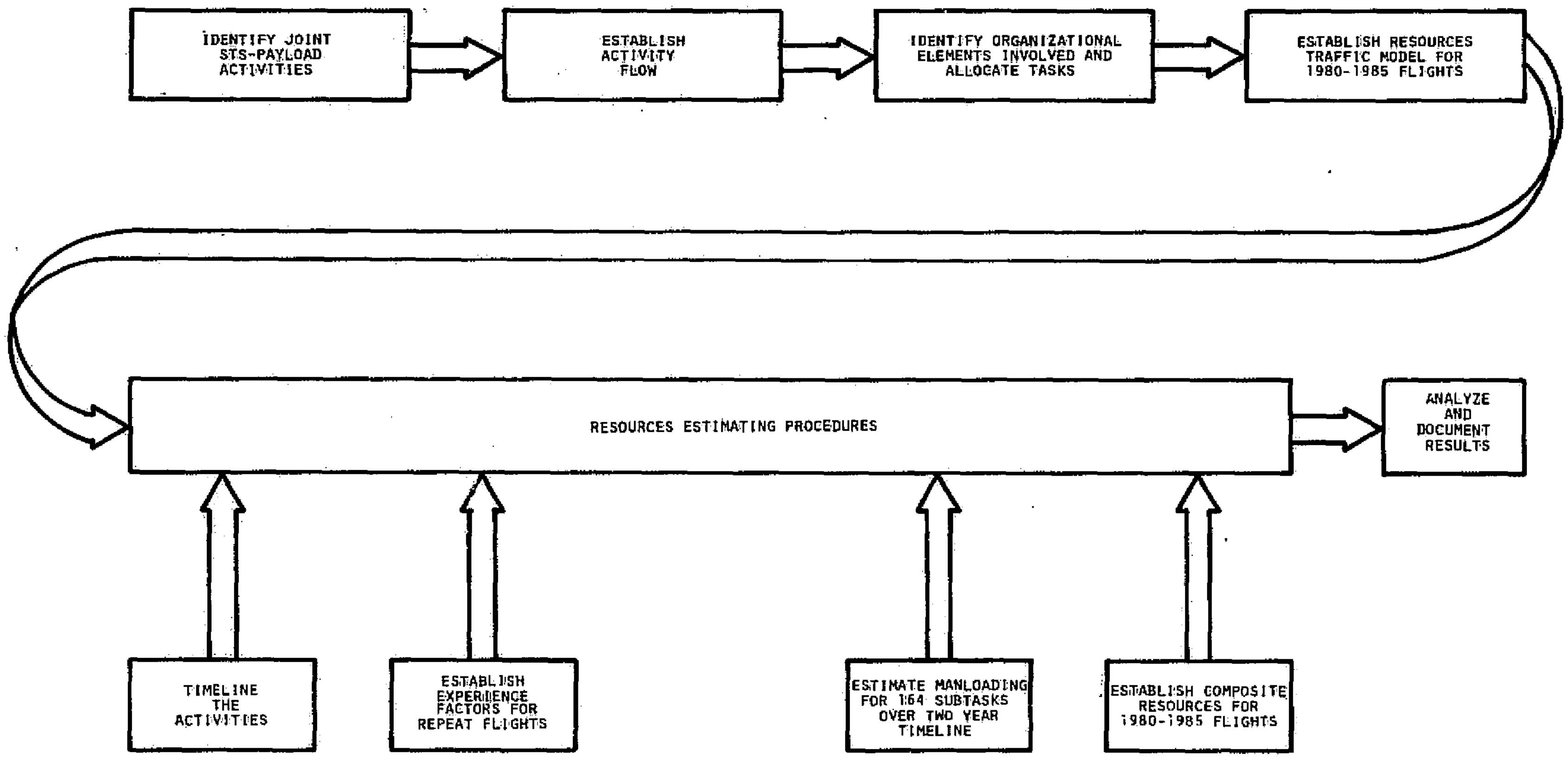


ACTIVITY FLOW FOR JOINT STS-PAYLOAD FLIGHT PREPARATION

This chart depicts the general flow of Joint STS-Payload activities and tasks in preparation for flight as follows:

a. The Joint Program/Project Engineering Functions are the initial activity with development of the Joint Project Plan. It includes task assignments, schedules, and development, if Joint Flight Requirements and Flight Operations Data Base that constitute key inputs to the other activities shown.

b. Integrated Flight Planning includes trajectory design, timelines, consumables analyses, and subsystems performance analyses.

c. System Support involves communications and data handling/processing, range and network requirements, and software and crew systems analyses.

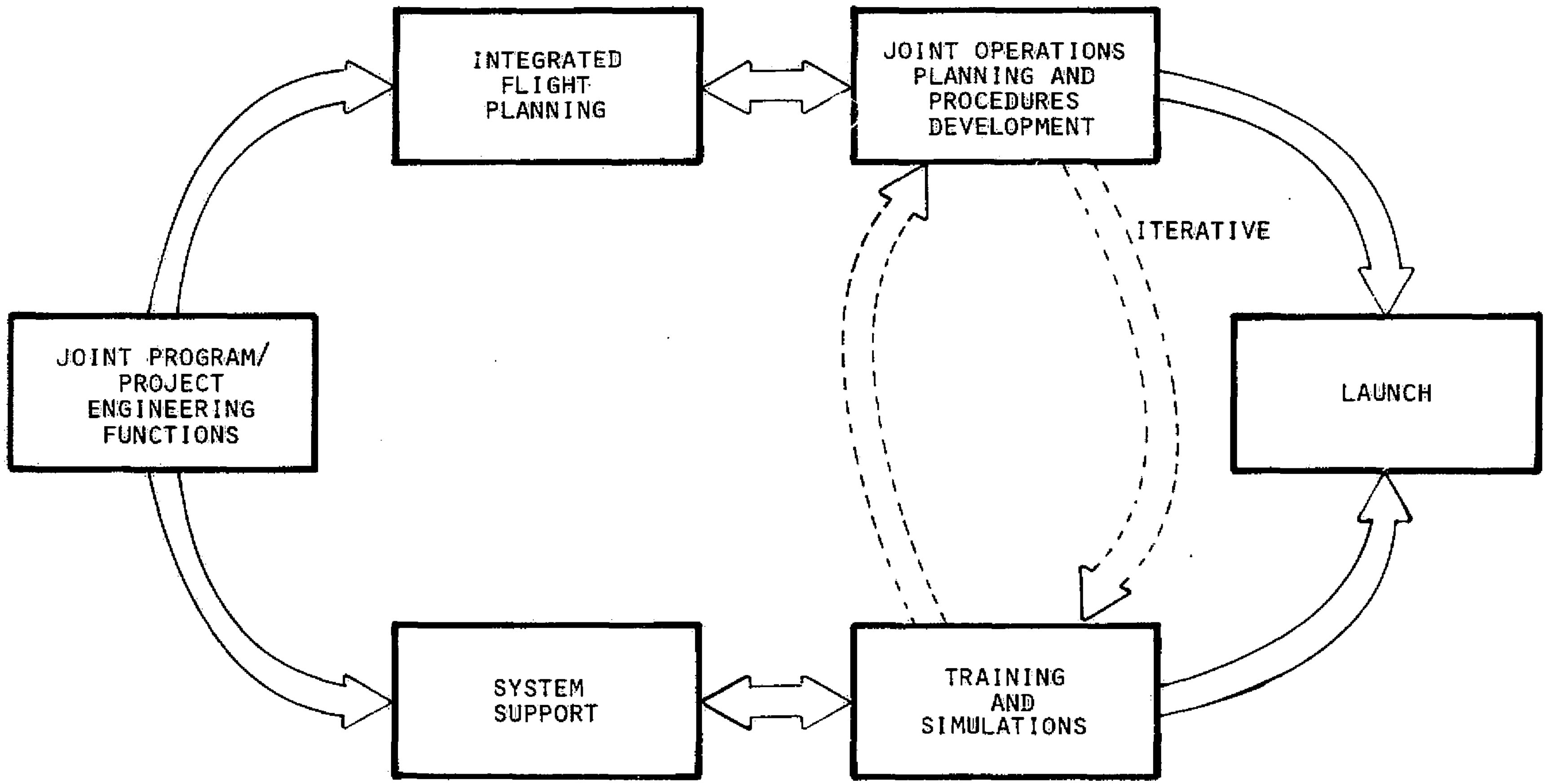
The last activities to be completed, since they depend heavily on input from trajectory design, crew activity timeline and systems analyses which are completed earlier are:

a. Joint Operations Planning and Procedures Development. This involves integrated command, planning, flight rules and flight techniques development and onboard/FCR/POCC procedures and supporting data.

b. Training and Simulations are accomplished to ready the Joint/Integrated Crews for the flight and verify timelines and procedures.

As indicated by the dashed arrows, the Joint Operations Planning and Procedures Development is an iterative activity with Training and Simulations.

ACTIVITY FLOW FOR JOINT STS-PAYLOAD FLIGHT PREPARATION



INVOLVEMENT OF OPERATIONAL ELEMENTS IN PREPARATIONS FOR FLIGHT OPERATIONS

This chart shows the involvement of operational functions as associated with the 25 preflight activities. "P" designated the functions recommended for primary responsibility. "I" indicates those functions which provide major reviews, support and/or inputs.

The first three function columns indicate functions performed by the program offices, i.e., STS Program Office, Payload Program Office and Shuttle Payload Integration and Development Program Office, (SPIDPO), respectively. SPIDPO logically would be responsible for the majority of program office activities which involve interfaces between the STS and payloads, with notable exception of the flight requirements specified by the Payload Program Offices.

Within the Payload Operations Centers (POC's), which include JSC, GSFC, and JPL, the supporting functions involve Payload Operations Control Centers (POCC's), Payload Coordinators (PC's), Flight Design, Crew Activity Planning, Training and Simulations. Communications and Data Handling and Data Processing.

The MCC-H (STS Operator) has been recommended as the responsible function for the flight and operations planning activities which comprise the majority of Joint Preflight Activities.

Other functions which support or have inputs to the activities include; Integrated Operations Manager (IOM), Network Operations, Launch/Landing Site Interfaces, STS Flight Crew, Payload Flight Crew and Mission Manager.

INVOLVEMENT OF OPERATIONAL ELEMENTS IN PREPARATIONS FOR FLIGHT OPERATIONS

STS/PAYLOAD OPERATIONAL FUNCTIONS / JOINT ACTIVITY	SPIDPO	STS PROJECT OFFICE	PAYLOAD PROJECT OFFICE (INDIVIDUAL OR INTEGRATED)	POC: POCC	POC: PAYLOAD COORDINATOR (PC)	POC: FLIGHT DESIGN GROUP	POC: CREW ACTIVITY PLANNING	POC: TRAINING AND SIMULATION	POC: COMMUNICATIONS AND DATA HANDLING	POC: DATA PROCESSING	MCC–H (STS OPERATOR)	INTEGRATED OPERATIONS MANAGER (IOM)	NETWORK OPERATIONS	LAUNCH/LANDING SITE INTERFACES	STS FLIGHT CREW	PAYLOAD FLIGHT CREW	MISSION MANAGER
• JOINT PROJECT PLANNING	P	I	I	I	I	I	I	I	I	I	I	I	I	I			I
• JOINT FLIGHT REQUIREMENTS DEVELOPMENT	I	I	P		I						I	I					I
• STS–PAYLOAD FLIGHT OPERATION DATA BASE	P	I	I														
• STS-PAYLOAD FLIGHT CONFIGURATION IDENTIFICATION AND CONTROL	P	I	I		I							I					I
• INTEGRATED FLIGHT SAFETY EVALUATION AND MONITORING	P	I	I		I						I	I			I	I	I
• COMMUNICATION AND DATA HANDLING	I	I	I	I	I	I	I		I	I	P		I	I			I
• INTEGRATED RANGE REQUIREMENTS	I	I	I			I			I	I	P		I	I			
• INTEGRATED NETWORK REQUIREMENTS	I	I	I	I		I	I		I	I	P		I	I			
• JOINT DATA PROCESSING	I	I	I	I		I			I	I	P		I	I			
• FLIGHT SOFTWARE EVALUATION AND MODIFICATION	I	I	I								P				I	I	I
• GROUND SOFTWARE EVALUATION AND MODIFICATION	I	I	I	I					I	I	P		I	I			I
• CREW SYSTEMS EVALUATION AND AUGMENTATION	I	I	I				I	I			P				I	I	I
• TRAJECTORY ANALYSIS AND DESIGN	I	I	I			I	I	I	I		P		I				I
• ATTITUDE TIMELINING	I	I	I			I	I	I			P				I	I	I
• INTEGRATED CREW ACTIVITY PLANNING	I	I	I	I		I	I	I			P				I	I	I
• INTEGRATED CONSUMABLES ANALYSIS	I	I	I			I	I	I			P				I	I	I
• SUBSYSTEM PERFORMANCE ANALYSIS	P	I	I			I	I				I						
• INTEGRATED CONTINGENCY PLANNING	I	I	I		I	I	I	I	I		P	I	I		I	I	I
• FLIGHT TECHNIQUES DEVELOPMENT	I	I	I	I	I	I	I	I	I		P		I	I	I	I	I
• INTEGRATED COMMAND PLANNING AND PROCEDURES DEVELOPMENT	I	I	I	I		I	I	I	I		P		I	I	I	I	I
• INTEGRATED FLIGHT RULES DEVELOPMENT	I	I	I	I	I			I			P	I	I	I	I	I	I
• ONBOARD/FCR/POCC PROCEDURES CHECKLISTS REFERENCE DATA DEVELOPMENT				I		I	I	I	I		P				I	I	
• JOINT/INTEGRATED TRAINING AND SIMULATION REQUIREMENTS DEVELOPMENT	I	I	I	I		I	I	I			P				I	I	I
• JOINT/INTEGRATED TRAINING AND SIMULATION PLANNING	I	I	I	I		I	I	I			P				I	I	I
• CONDUCT JOINT/INTEGRATED TRAINING AND SIMULATIONS				I		I	I	I			P				I	I	

LEGEND: P = PRIMARY RESPONSIBILITY
I = MAJOR INPUT/SUPPORT

TYPICAL RESOURCES ESTIMATES OF AN OPERATIONAL TASK

This chart demonstrates the total manpower resources required for:

a. A Spacelab 7-Day Flight.

b. Flight No. 1 of this type flight.

c. Tasks associated with the System Support Activity.

d. The time period of 22 months before launch until launch.

This technique was used in determining the manpower requirements for each of the 60 summary worksheets discussed previously.

TYPICAL RESOURCES ESTIMATES OF AN OPERATIONAL TASK

1A: SPACELAB, 7-DAY
1A2: SYSTEM SUPPORT ACTIVITY
1AA2: EXPERIENCE FACTORS FOR FLIGHT 1

TIME IN YEARS-MONTHS BEFORE LAUNCH / TASKS	EXPERIENCE FACTOR: FLIGHT 1																							
	L-2 YEARS												L-1 YEAR											
	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Communications and Data Handling				1	1	2	2	2	2							1	1	1					1	1
Integrated Range Requirements			1	1	2	2	2	2	1	1						1	1	1						1
Integrated Network Requirements			1	1	1	1	1	1						1	1								1	1
Joint Data Processing				1	1	2	2	2	1	1					1	1	1	1					1	1
Flight Software Evaluation and Modification			1	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ground Software Evaluation and Modification			1	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Crew Systems Evaluation and Augmentation							1	2	2	1	1									1	1	1	1	1
TOTAL MANLOADING PER MONTH			4	7	9	11	12	12	8	5	3	2	2	3	4	5	5	5	2	3	3	3	6	7

TYPICAL ACTIVITY MANLOADING SHOWING COMPARATIVE EXPERIENCE FACTORS

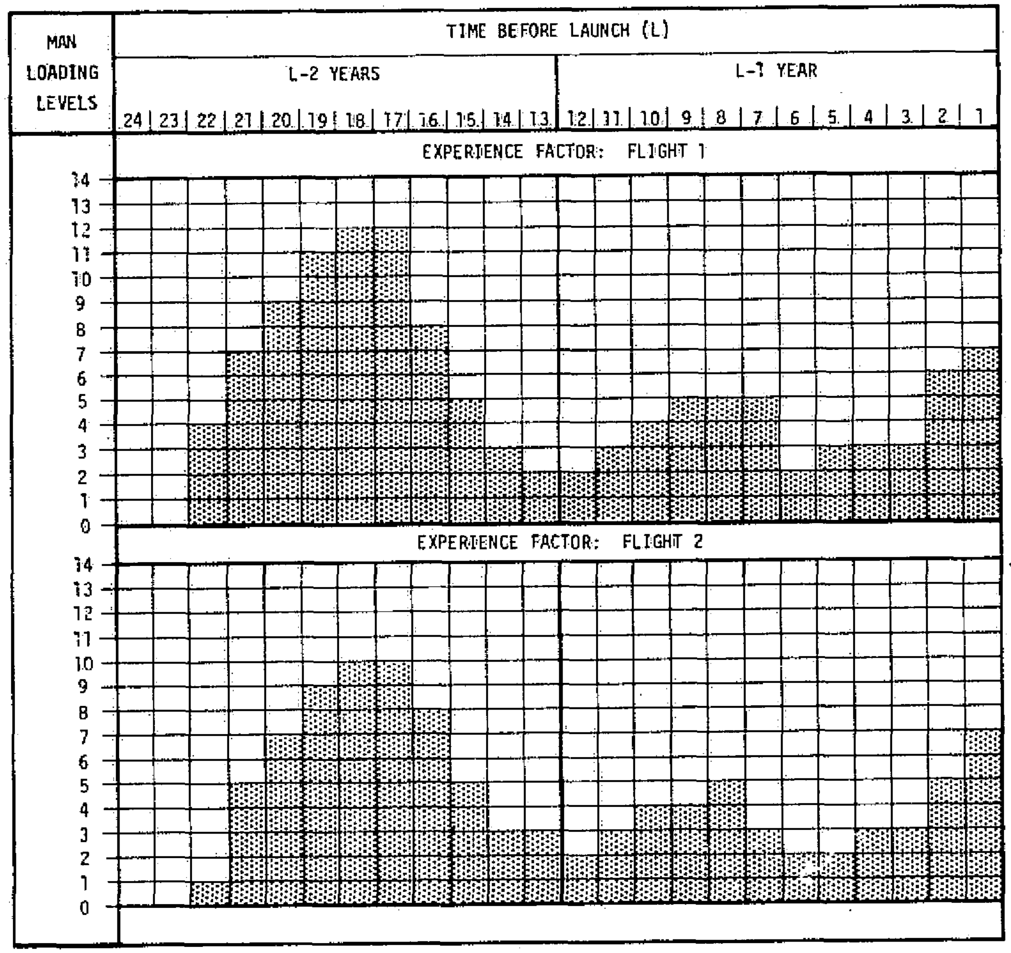
This chart shows two of the three experience factors (not shown is the Flight 5 Experience Factor), which were used as summation worksheets for the composite manpower curves for each of 60 activity cases. These 60 cases provided totals for the five major activities, for the four payload categories and three experience factors.

The procedure followed in estimating man-loading was to analyze each task and sub-task in terms of the efforts to be performed, when they should be performed, what functional organizations and skills were involved, the number of separate interfaces, documentation and/or products to be produced, and the likely availability of input material or data from sources outside the joint task performer group.

This analysis was made on a task by task basis estimating the manpower for each payload category starting with the first flight and then proceeding to estimate the reduction in manpower resulting from the experience factors.

TYPICAL ACTIVITY MANLOADING SHOWING COMPARATIVE EXPERIENCE FACTORS

SPACELAB PAYLOADS 7-DAY FLIGHTS, SYSTEM SUPPORT (1AA2)



APPROACH TO SUMMARIZING COMPOSITE RESOURCES ESTIMATES

This chart illustrates the sequence of the performance of the tasks involved in the final step in estimating the Composite Resources.

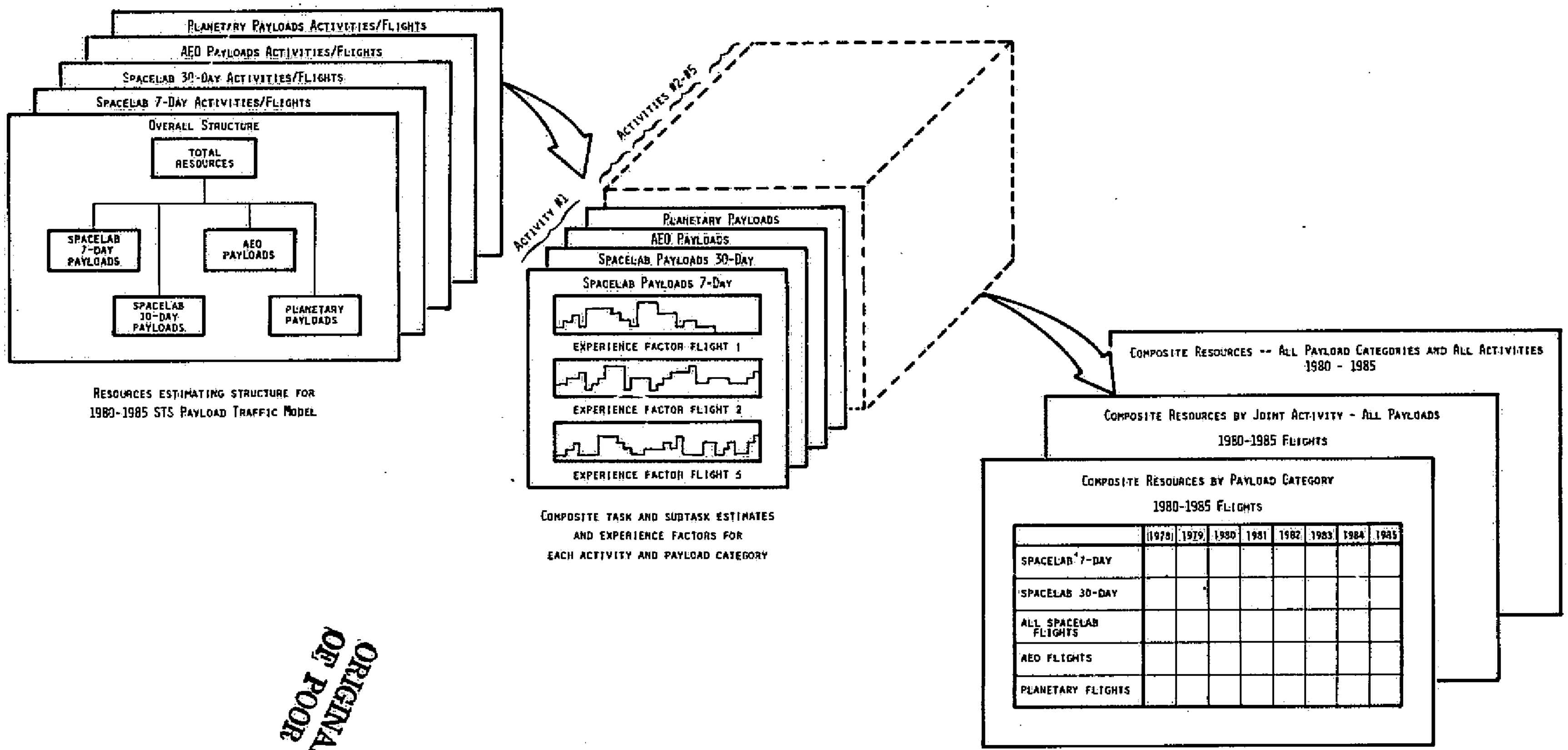
These tasks consisted of generating:

a. A Resources Estimating Structure.

b. Composite Task and Subtask Estimates and Experience Factors for Each Activity and Payload Category.

c. Summations of Composite Resources.

APPROACH TO SUMMARIZING COMPOSITE RESOURCES ESTIMATES



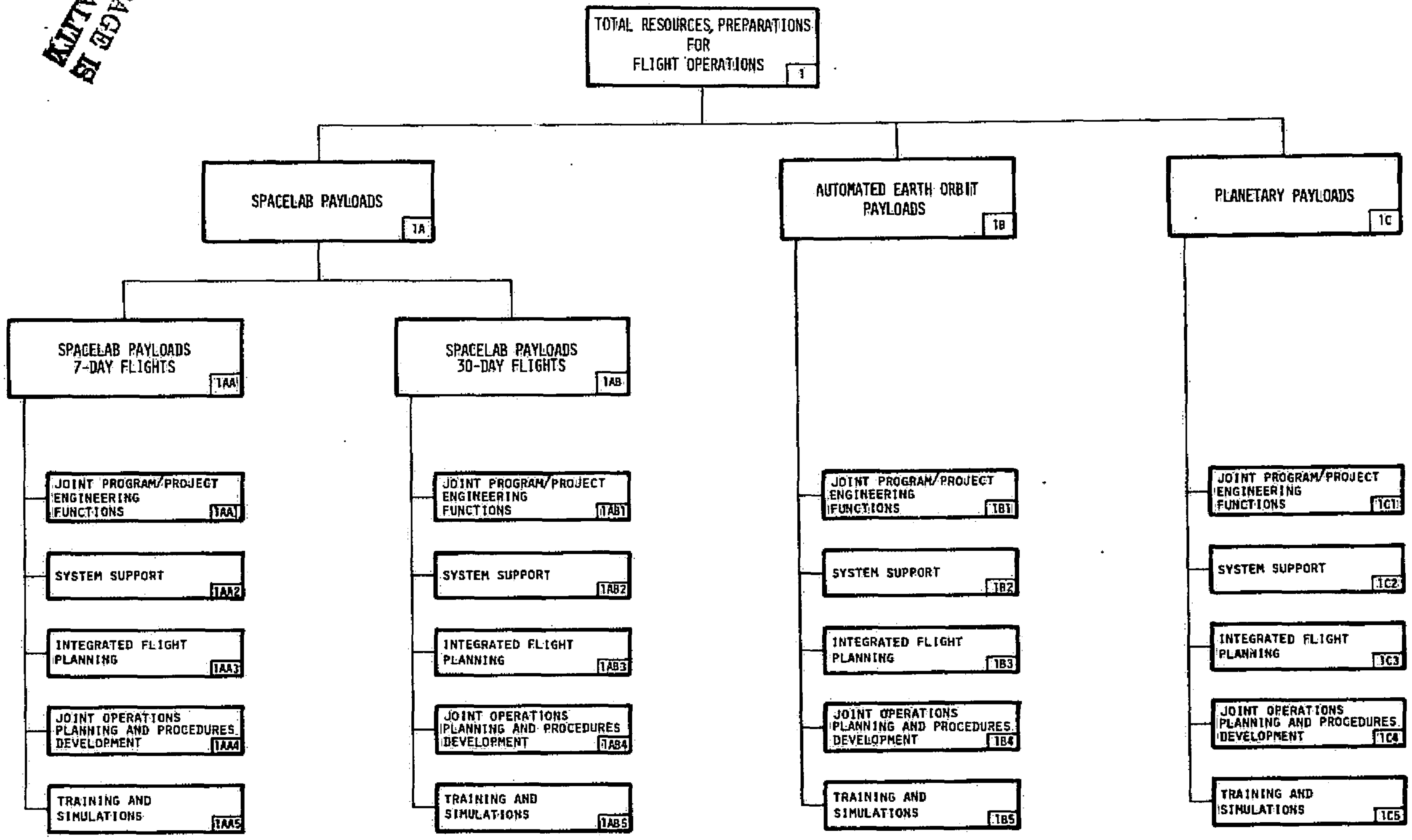
RESOURCES ESTIMATING STRUCTURE FOR 1980-1985 STS-PAYLOAD TRAFFIC

A resources estimating structure as shown on the facing chart, was developed to facilitate computing the composite resources by month and year.

In addition to the structure shown on this chart additional charts were used to assign a specific flight number to each of the activities under each flight type.

The diagrams assigned unique code numbers to Payload Categories, activities, and individual flights to organize these elements into a hierarchy for use in computing the composite results.

RESOURCES ESTIMATING STRUCTURE FOR 1980-1985 STS-PAYLOADS TRAFFIC



SUMMARY OF RESOURCES REQUIREMENTS, FLIGHTS 1, 2 AND 5

This chart is a Summary of Resource Requirements, Flights 1, 2 and 5 for Joint Flight Preparation Activities. It provides a summary comparing the total resource requirements for each Joint Activity with respect to each of the three experience factor flights as well as with respect to the average for all Payload categories for each experience factor flight.

This chart provides a direct numerical comparison of the difference in resources required for Flights 1, 2 and 5, for each joint acvitity and each flight type. The last column on this figure provides the average manpower for each activity and each experience factor among all the flight types.

Resources planning personnel can compare the resource requirements for an activity within a given flight type with the average for that activity for all flight types.

The sum of the averages in the bottom right hand columns indicates that the average resources for all activities and flight types is 15% less for Flight 2 than Flight 1 and 25% less for Flight 5 than for Flight 2. Flight 5 is 38% less than Flight 1.

SUMMARY OF RESOURCE REQUIREMENTS, FLIGHTS 1, 2 AND 5

ACTIVITY	STS PAYLOAD CATEGORY												AVERAGE FOR ALL PAYLOAD CATEGORIES		
	SPACELAB 7-DAY FLIGHTS TOTAL MAN-MONTHS			SPACELAB 30-DAY FLIGHTS TOTAL MAN-MONTHS			AEO FLIGHTS TOTAL MAN-MONTHS			PLANETARY FLIGHTS TOTAL MAN-MONTHS					
	EXPERIENCE FACTOR			EXPERIENCE FACTOR			EXPERIENCE FACTOR			EXPERIENCE FACTOR			EXPERIENCE FACTOR		
	FLIGHT 1	FLIGHT 2	FLIGHT 5	FLIGHT 1	FLIGHT 2	FLIGHT 5	FLIGHT 1	FLIGHT 2	FLIGHT 5	FLIGHT 1	FLIGHT 2	FLIGHT 5	FLIGHT 1	FLIGHT 2	FLIGHT 5
1. JOINT PROGRAM/PROJECT ENGINEERING FUNCTIONS	1AA101 102	1AA102 78	1AA105 55	1AB101 123	1AB102 100	1AB105 65	1B101 99	1B102 60	1B105 57	1C101 90	1C102 71	1C105 51	104	32	57
2. SYSTEM SUPPORT	1AA201 121	1AA202 106	1AA205 81	1AB201 138	1AB202 115	1AB205 92	1B201 123	1B202 105	1B205 84	1C201 115	1C202 97	1C205 81	124	106	85
3. INTEGRATED FLIGHT PLANNING	1AA301 93	1AA302 82	1AA305 62	1AB301 120	1AB302 100	1AB305 81	1B301 65	1B302 55	1B305 38	1C301 71	1C302 58	1C305 42	87	74	56
4. JOINT OPERATIONS PLANNING AND PROCEDURES DEVELOPMENT	1AA401 65	1AA402 51	1AA405 36	1AB401 74	1AB402 62	1AB405 45	1B401 55	1B402 40	1B405 29	1C401 57	1C402 42	1C405 30	63	49	35
5. TRAINING AND SIMULATIONS	1AA501 50	1AA502 39	1AA505 28	1AB501 58	1AB502 47	1AB505 36	1B501 23	1B502 18	1B505 15	1C501 23	1C502 18	1C505 15	39	31	24
SUM, ALL ACTIVITIES PER FLIGHT	431	356	262	513	424	319	365	298	223	356	286	219	417	342	257

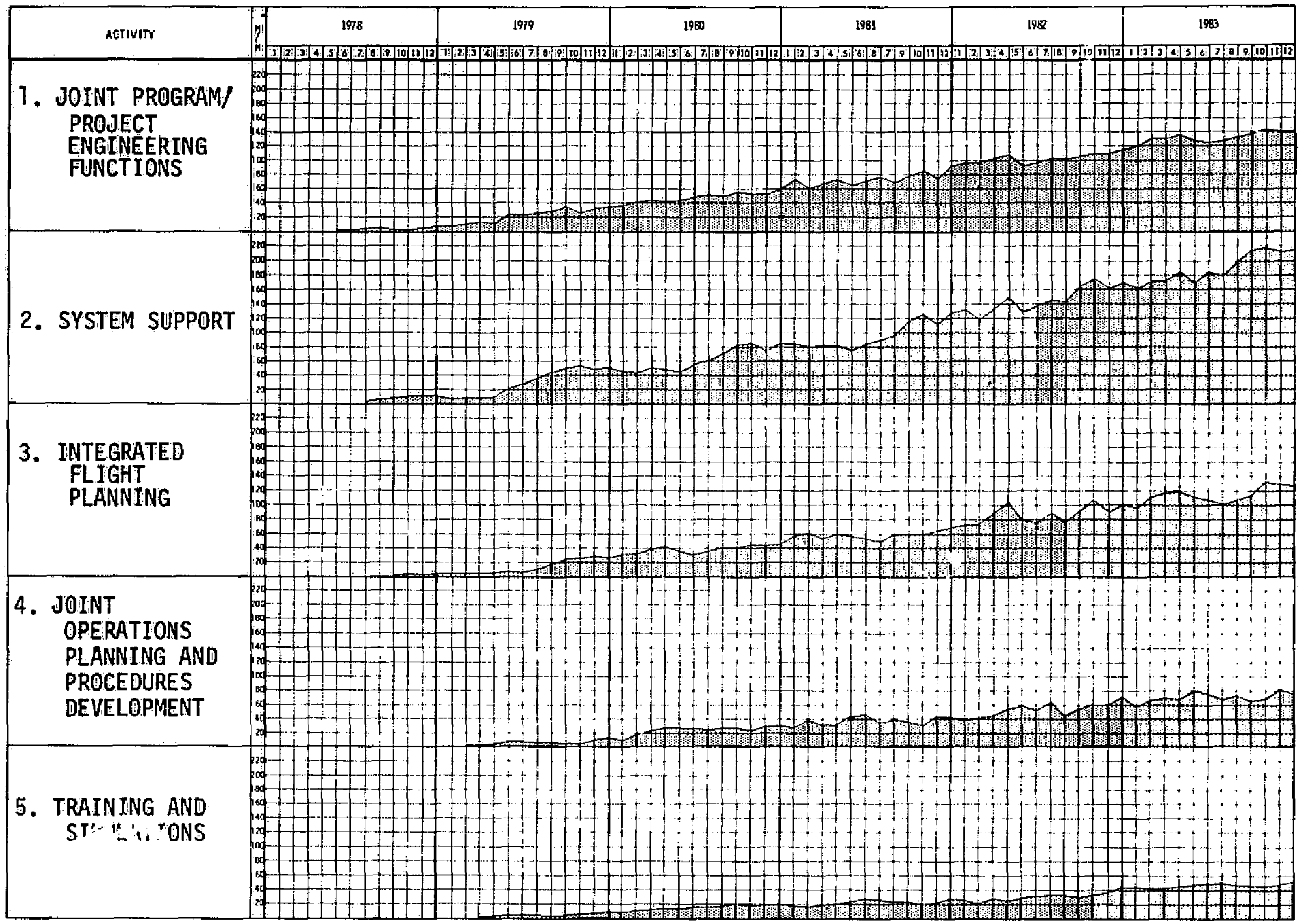
COMPOSITE RESOURCES BY JOINT ACTIVITIES

This chart shows the relative manpower for each activity by month and year as well as the direct comparison between support requirements for each activity.

An indication of the rate of build up of resources required for each activity and the relationship of the starting times for each of the activities is immediately obvious from observation of these curves.

It will be noted that human resources for training and simulations are not required until 10 months later than activation of the activities for Joint Program/Project Engineering Functions.

COMPOSITE RESOURCES BY JOINT ACTIVITIES



TOTAL RESOURCES ALL FLIGHT TYPES — ALL ACTIVITIES

This chart showing Total Resources for All Flight Types and All Activities indicates a fairly linear build up in the total professional manpower resources required for all preflight planning, training and simulations activities beginning in 1978 and extending through 1985 An analysis of the curve from 1979 which is the first full year of activities through 1983 reveals the following with regard to total resources required:

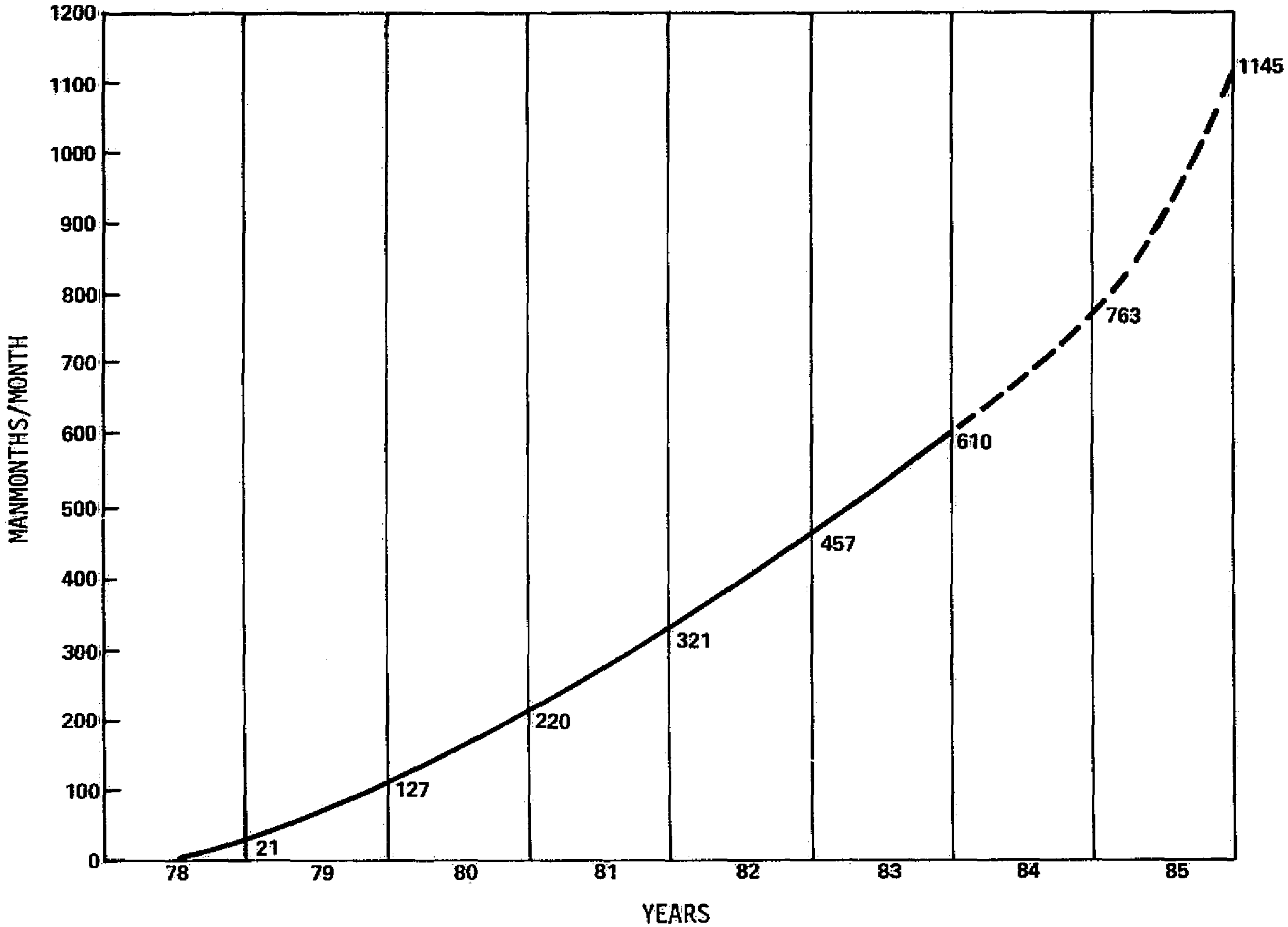
a. The total manpower resources required over the five year span is 17,809 man months.

b. The average number of professional personnel required during this period for joint activities is about 300 per year.

c. The average rate of increase in personnel from year to year over this four year period is 110 personnel per year.

The dashed portion of the curve provides a gross estimate of the growth rate of manpower for th `984 and 1985 period. This dashed curve is an extrapolation of the solid curve based on an average growth of flight types per year.

TOTAL RESOURCES ALL FLIGHT TYPES -- ALL ACTIVITIES



OVERALL STUDY CONCLUSIONS AND RECOMMENDATIONS

OVERALL STUDY CONCLUSIONS

This chart depicts the major conclusions derived from this study consisting of:

a. The overriding factor which produced these conclusions was the fact that each selected center had much more previous experience and existing capability with respect to its assigned payload responsibility than any other NASA Center.

b. The prime factors influencing the decisions for backup support were:

1. GSFC backup Spacelab Payloads because of similarity of experience with unmanned Earth Orbiting Payloads.
2. JSC backup Automated Earth Orbiting Payloads because of similarity of experience with manned Earth Orbiting and Lunar experiments.
3. JPL backup both AEO and Spacelab Payloads in a limited fashion because of its experience in Payload control and related support.

c. Rather than each center developing a unique approach to its support of STS-Payloads, much can be done to coordinate real-time flight control procedures, implementation of activities in preapration for STS flights and in standardizing operational interfaces among the various STS operating elements, through a coordinated effort to bring these activities together.

OVERALL STUDY CONCLUSIONS

- BASED ON THE SURVEY OF CAPABILITIES OF SEVEN NASA CENTERS, IT WAS CONCLUDED THAT INITIAL CENTER RESPONSIBILITY FOR STS PAYLOAD MISSION CONTROL SHOULD LOGICALLY BE ASSIGNED TO:
  - JSC FOR SPACELAB PAYLOADS
  - GSFC FOR AUTOMATED EARTH ORBITING PAYLOADS
  - JPL FOR PLANETARY PAYLOADS

- AS A RESULT OF INVESTIGATIONS OF POCC AND SYSTEM STANDARDIZATION, IT WAS CONCLUDED THAT A REASONABLE LEVEL OF PAYLOAD FLIGHT CONTROL STANDARIDZATION DICTATES AN ULTIMATE CAPABILITY FOR:
  - JSC AND GSFC TO HANDLE SPACELAB PAYLOADS
  - GSFC AND JSC TO HANDLE AUTOMATED EARTH ORBITING PAYLOADS
  - JPL TO HANDLE PLANETARY PAYLOADS WITH A BACKUP CAPABILITY TO HANDLE SPACELAB AND AEO PAYLOADS

- STUDY OF EXISTING AND PLANNED CAPABILITIES OF NASA CENTERS FOR PAYLOAD FLIGHT CONTROL REVEALS A NEED FOR STANDARDIZATION AND INCREASED COMPATIBILITY AMONG THE CENTERS IN THE AREAS OF:
  - REAL-TIME FLIGHT CONTROL RESOURCES AND PROCEDURES
  - IMPLEMENTATION OF ACTIVITIES IN PREPARATION FOR STS FLIGHT OPERATIONS
  - INTERFACES BETWEEN POCC'S AND STS OPERATIONAL ELEMENTS

OVERALL STUDY CONCLUSIONS (CONTINUED)

d. The following ground rules and assumptions should be used with respect to defining a Data Base Management System.

1. The Communication Processors at each site should be compatible to allow for standardization of computer-to-computer operation and simplify software design.

2. A Payload Operation Center communication processor should be the focal point of distribution for all Data Bases residing at that Center.

3. JPL and AF/STC do not share Experiment Data Bases with other Centers.

4. KSC is assumed to have the Launch Processing System (LPS) Data Base and VAFB will also utilize it for WTR launches and landings, as well as having a supplemental data base at VAFB.

5. The MCC-H (STS Operator) contains all STS/Payload Operations Data Bases even though they may be housed in JSC facilities.

6. The Center's support to POCC's resides in the Center's computer facilities, and POCC/PI Common Data Bases are assumed to reside in the POC computer facility.

e. An evolutionary approach to an integrated, standardized multi-center system for STS-Payload Flight Control can build toward an ultimate capability to support the full traffic model with minimum expenditures. A final system architecture which uses the existing capabilities initially and expands the capability just ahead of the growth in requirements can be implemented. An integrated NASA-wide system will permit pooling resources and will eliminate needless redundancy, thus reducing cost.

f. A key decision which should be made as early as possible is that of expanding the initial capabilities of GSFC/JSC/JPL Payload Operations Control Centers or adding additional Centers to accommodate increasing loads as the flight traffic model increases. This decision will affect the architecture of the ultimate system and the methods of achieving a full capability. The manner in which users will interface with payload operations will also be affected.

OVERALL STUDY CONCLUSIONS (CONTINUED)

- A NASA-WIDE SUPERVISORY DATA BASE MANAGEMENT SYSTEM FOR STS-PAYLOADS WILL:
  - ENHANCE DATA TRANSFER AMONG OPERATIONAL ELEMENTS
  - MINIMIZE MAINTENANCE OF REDUNDANT DATA BASES
  - REDUCE THE SIZE OF THE INDIVIDUAL CENTERS DATA BASE MANAGEMENT SYSTEM
  - HELP INSURE THE CURRENCY OF OPERATIONAL DATA

- AN EVOLUTIONARY APPROACH TO SYSTEM ENHANCEMENT UTILIZING THE THREE SYSTEM CONCEPTS DERIVED IN THE STUDY, IS THE MOST EFFICIENT WAY TO DEVELOP THE ULTIMATE CAPABILITY FOR SUPPORT OF THE STS-PAYLOAD TRAFFIC MODEL.
  - SIMPLIFIED OPERATIONAL TEAM STRUCTURES
  - STREAMLINED COMMAND AND CONTROL CONCEPTS
  - POCC STANDARDIZATION
  - ECONOMICAL WIDEBAND COMMUNICATIONS VIA DOMSATS
  - STANDARD PORTABLE POCC'S

- IN ORDER TO SUPPORT THE STS-PAYLOAD FLIGHT TRAFFIC MODEL, BEGINNING WITH PRESENT NASA CAPABILITIES, IT WILL BE NECESSARY TO IMPLEMENT THE FEATURES OF THE THREE SYSTEM CONCEPTS AND STANDARD POCC CONCEPT BY MID-1982.

STUDY RECOMMENDATIONS

An early program is needed to establish standards for payload design so that standardization of ground operating equipment and software can be achieved. Standardization can start by utilizing the best of all presently existing capabilities of the various Centers. Ultimately, a set of standards for communications and data handling from which users can select one or more formats from a "menu" would facilitate the use of processing firmware on the ground and permit simplification of procedures, documentation, training and other aspects of system support.

The ultimate system should optimize standardization of POCC's for all payloads to the extent practicable. Standardization can extend to much of the system software, will promote system versatility for support of various payloads and will facilitate fast turn-around from one flight to another. Spares, maintenance and other logistics functions will be simplified through optimized standardization.

The achievement of standardization should begin by adopting the best of existing resources and extending their use to the other Centers. As existing systems become obsolete and reach the end of their normal life cycle, new resources, optimized to meet the ultimate requirement, can be phased into the system.

In order to determine composite requirements for resources for the STS Operator tasks in long range planning, it is recommended that the same methodology be used as in this study task. This would maximize the probability of identifying areas of overlap or gaps in planning activities between the joint operation planners and the unique STS Operator planning.

STUDY RECOMMENDATIONS

- STANDARDIZATION - STANDARDIZATION - STANDARDIZATION
  - PAYLOAD COMMUNICATIONS AND DATA HANDLING
  - POCC'S
  - DATA MANAGEMENT
  - OPERATIONAL PROCEDURES
  - PREFLIGHT PLANNING, TRAINING AND SIMULATION METHODS
  - OPERATING INTERFACES

- RECOMMEND TIMELY IMPLEMENTATION OF THE STANDARD POCC CONCEPT AND THE ACCOMPANYING SYSTEM ENHANCEMENT TO INSURE THE ULTIMATE CAPABILITY REQUIRED BY THE TRAFFIC MODEL

- ACCOMPLISH STANDARDIZATION BY MAINTAINING THE BEST EXISTING OR PLANNED CAPABILITIES OF EACH CENTER AS A BASIS FOR EXPANSION

- UTILIZE STUDY METHODOLOGY TO DETERMINE RESOURCES REQUIRED OF THE STS OPERATOR. THIS WILL ASSIST IN IDENTIFYING ANY GAPS OR OVERLAPS IN THE ACTIVITIES AND TASKS.

STUDY RECOMMENDATIONS (CONTINUED)

In order to quantify the system effectiveness of limited standardization for POCC's as a cost savings measure, a cost analysis of the concept should be performed. This cost analysis will develop the specific areas of cost advantage which will point to programs which should be undertaken to develop the most beneficial standardization features.

As is always the case, manpower is the major resource required for STS-Payload Operations. Consequently, any steps which can be taken to reduce manpower can result in significant savings. Some of the potential areas to explore for these savings are listed on the facing page.

Now that the major areas of resource expenditure have been identified for pre-flight planning activities, it may be appropriate to examine some of these joint activities as candidate areas to include in the user charge allocations.

The use of mini-computers will enhance system simplicity and ease of modularization of system software.

STUDY RECOMMENDATIONS (CONTINUED)

- A COST ANALYSIS OF THE STANDARD POCC NETWORK DEVELOPMENT CONCEPT SHOULD BE UNDERTAKEN TO QUANTIFY THE COST OF IMPLEMENTATION AND THE SAVINGS WHICH WOULD ACCRUE DURING THE STS OPERATIONAL ERA.

- SINCE MANPOWER IS THE MAJOR RESOURCE IN OPERATIONAL PLANNING, RESOURCES SHOULD BE CONSERVED THROUGH:
  - AUTOMATION
  - ELIMINATION OF REDUNDANCY
  - CENTRALIZED FUNCTIONAL CAPABILITIES FOR SIMILAR EFFORTS
  - PRODUCTION LINE TECHNIQUES FOR REPETITIVE ACTIVITIES
  - USE OF STANDARD MODULES - FOR FLIGHT PLANNING
  - CROSS-TRAINING BETWEEN SPECIALIZED PERFORMER GROUPS.

- IT IS RECOMMENDED THAT THE RESOURCES ESTIMATES FOR THE JOINT PREFLIGHT PREPARATION ACTIVITIES BE ASSESSED FOR IMPACT ON THE USER CHARGE ALLOCATIONS.

- EXPLOIT THE USE OF MINI-COMPUTERS TO SIMPLIFY AND MODULARIZE THE SYSTEM.